Wednesday, 5th April at 3-45 p.m.

Sir Robert Watson-Watt (President of the Royal Meteorological Society)

The Earth's Atmosphere.

A broad survey is made of the main physical characteristics of the earth's atmosphere, in so far as they are yet known. The investigations which led to the recognition of the troposphere and the stratosphere as regions separated by a thermally recognisable boundary, the tropopause, have been reviewed in the discourse by Dr. Scrase. Some ways in which the microclimatology and micrometeorology of the troposphere require clarification are noted, as is recent work on the still uncharted stratosphere.

The ozonosphere illustrates the ingenious and fruitful combination of evidence carried by light waves and matter from outer space, and by sound waves from the earth's surface, in establishing vitally important physical characteristics.

Finally a rough outline of the study of the ionosphere brings this last discourse to an appropriate meeting point with the first, by Professor Chapman.

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PHYSICAL SOCIETY
THIRTY-FOURTH ANNUAL EXHIBITION

Apparatus and instruments which are in production are indicated by a dagger †; asterisks are not being used for new instruments as in earlier years. The description of any exhibit to be shown in operation is followed by the word DEMONSTRATION.

Stand 1
TECHNE (CAMBRIDGE) Ltd.,
Duxford, Cambridge

Photoelasticity Polariscope†. The introduction of new photoelastic materials and of improved polarizers and light sources has made possible the design and production, at a reasonable cost, of this instrument specially suited for use by engineers. Designed by Dr. C. Mylonas of Messrs. Aero Research Ltd., it incorporates a number of valuable features. The polarizer and analyser are coupled together and each 10° of rotation indicated by a ' click ' mechanism. The quarter-wave plates are carried in rotatable mounts so that they can be instantly brought into use. Other features are the use of a miniature camera permitting short exposure times, an improved straining frame operated by compressed air, and the grouping of all controls so that they can be operated from one position behind the screen on which the isoclinics can be drawn.

Influx Viscometer for Industrial Use†. A known constant air pressure produced by a weighted piston forces the liquid under test into a horizontal glass capillary tube which is marked in such a way that the viscosity in poises is numerically equal to the time taken for the liquid column to pass from one mark to another. This instrument is an absolute one and does not require calibration with a liquid of known viscosity. It is of value both for normal and non-Newtonian liquids, is easily cleaned, and covers the range from about 50 centipoises upwards. It works equally well with opaque or transparent liquids and, since the liquid is in a closed container, there are no troubles due to loss of solvents or skinning. Neither the volume nor the density of the test specimen have to be determined. No special precautions are required to secure accurate alignment of the capillary.

A Temperature Controlled Bath for Industrial Use†. This is a simple and robust water bath specially designed for use with the Techne Influx Viscometer, the Techne Gelation Timer and for other purposes where a relatively small and shallow bath is sufficient, and where control by a bimetallic thermostat is permissible. The shape of the bath is such that the water, rapidly circulated by a concealed impeller, does not form cold pockets. A bank of six gelation timers can be used simultaneously, and provision is made for holding a number of samples for viscosity tests.

Vibration Pick-Ups†. A very small glass capillary tube containing mercury and filled with hydrogen is coated externally with two conducting films. The changes in capacity indicate, through an amplifier, the vibrations received. The tube is mounted in a convenient unit for attachment to aero engines, etc. These pick-ups are made for, and to the design of, Messrs. Rolls Royce Ltd., Derby. (Patent applied for.)

Stand 2

J. LANGHAM THOMPSON & CO.,

Springland Laboratories, Stanmore, Middlesex.

Carrier Frequency Strain Gauge Measuring Equipment†. This is an improved version of the equipment that was exhibited last year. The stability has been improved and the size much reduced.

Capable of accurately measuring strains, static or dynamic, as low as 10^{-7}. This equipment is of very great use to almost all branches of engineering. Marrying up with this equipment are a complete range of strain gauge pick-ups for the measurement of pressure, acceleration, vibration, or applied forces.

Unbonded Strain Gauge Units†. These comprise a 4-element metallic filament array, each under definite initial stress and connected in the form of a Wheatstone Bridge. The mechanical structure is simple and sturdy, in spite of the fact that the filaments themselves are 0·001 in. diameter.

There are two major parts, a frame and an armature which moves with respect to the frame and is secured thereto by two very flexible suspensions.

The force or movement to be measured is applied to the armature, the travel of which is restricted, thus permitting the unit to be overloaded without damage to the sensitive elements and without loss of calibration.

The four elements are strung between eight posts. Four posts are mounted on the armature and four others are mounted on the frame. One end of each element is fixed to an armature post and the other end to a frame post. When the armature moves (whilst the frame stands still), two elements will be in compression and the other two in tension. The resultant change in the resistance of the arms can then be definitely related to the forces producing this change.

These units have a very high sensitivity and the construction lends itself to a wide choice of operating mechanisms. Standard units are available for the measurement of pressure, acceleration and applied forces of a great variety of sensitivity, range and natural frequency.

High Sensitivity Balanced Galvanometer†. Produced in co-operation with the Admiralty Research Laboratories, these Galvanometers are a production version of the well-known " Downing " Galvanometer. The coil is completely balanced, and the total weight of the coil, mirror, and suspension, is less than 12 milligrams.

The complete unit is therefore most robust in spite of the fact that the sensitivity is of the order of 100 mm. per microampere (coil resistance 60 ohms), and the natural frequency higher than 20 c/s.

Using the same manufacturing techniques, but with stiffer and shorter suspensions, a range of Galvanometer units is being produced having a natural frequency of from 100 c/s. to 2000 c/s. Since ten of these units can be accommodated in a length of 1 in., they lend themselves admirably for use in multi-element Galvanometer cameras. In conjunction with the Unbonded Strain Gauge units, the sensitivity is such that, for a considerable number of purposes, the pick-up can be used to operate the Galvanometer directly, so dispensing with the need for complex and extensive amplifier equipment.

Multi-Element Tuned Reed Assembly†. Developed for the Royal Aircraft Establishment, this equipment comprises a bank of 52 tuned reeds covering a frequency range of from 300 c/s. to 1,200 c/s. The reeds are electromagnetically operated and are used in a case measuring only 4 in. × 13 in. The reed spacing is $\frac{1}{4}$ in.

Although intended for photographic recording in connection with flight measurements, the reed tips can be viewed by eye, and the complete equipment is therefore of interest in fields other than the one for which it was developed.

Stand 3

TELEPHONE MANUFACTURING CO., Ltd.,

St. Mary Cray, Kent

Dr. W. Saraga, Mr. F. Moss, Mr. D. T. Hadley.

Electronic Analogue Computer and Design Apparatus for Directional Aerial Arrays. The design of a directional aerial array, having a minimum number of aerials, to produce a required radiation pattern within certain specified tolerance limits, is a very tedious trial-and-error procedure, which consists of a great number of single trial calculations. In the last decade a number of mechanical and electromechanical analogue computers and pattern tracers have been evolved which reduce the time necessary for calculating a trial pattern from many hours to a few minutes.

The equipment demonstrated is an experimental model of a purely electronic computer in which the resultant radiation pattern is traced *instantaneously* on the screen of a cathode-ray oscillograph.* The main advantage of an *electronic* computer is not the reduction of the time necessary for tracing a single pattern, but the fact that a continuous variation of the design parameters becomes possible and that the result of this variation is continuously shown on the screen. Thus the designer is enabled to produce the required pattern not by a succession of separate trials but by direct visual curve fitting. In this way the analogue computing device becomes an analogue design apparatus. It is thought that in many other design problems the provision of an analogue design apparatus which gives an instantaneous picture of the trial curve would be of practical use.

The analogue computer demonstrated here uses two oscillations, one with frequency F_0 for simulating the H.F. currents in the aerials, and the other with frequency $f << F_0$ for simulating the movement of a hypothetical field strength meter which is travelling at a great distance from the array along the circumference of a circle around the array. It is required to compute the field strength, which would be measured by this meter, as a function of the angle of revolution. It can be shown that this function can be obtained as the envelope of the sum of a number of voltages, each of which is a carrier voltage of frequency F_0, phase modulated by a voltage of frequency f. Therefore, the analogue computer contains a number of phase modulators, the output voltages of which are added and applied to the cathode-ray oscillograph.

The model shown is built for an array consisting of 3 dipoles. Relative amplitudes and phases of the dipole currents and relative position of the dipoles can be adjusted at will.

*This idea was developed independently by G. H. Brown (see U.S.A. Patent No. 2,337,968 and *Proc. Inst. Radio Engrs.*, December, 1946) and by W. Saraga (British Patent No. 583,480).

Stand 4

A. E. CAWKELL ELECTRONIC ENGINEERS,

7, Victory Arcade, The Broadway, Southall

A representative selection of instruments for general laboratory and research work is shown. They are a few of a number of specialized instruments completed to special order singly, or in small batches for particular requirements.

Figure 1. Industrial Noise Measuring Instrument.

Industrial Noise Measuring Instrument† (Figure 1). An instrument for the tracing and measurement of noise sources in industrial appliances.

Brief Specification.

Contact microphone picks up noise from appliance.
Flat amplifier 20-20000 c/s.
Thermal or r.m.s. meter indication. Scale may be electronically ‘expanded’.
Alternatively continuously variable ‘Pass’ or ‘Reject’ filter.
External indicator triggered when noise level exceeds any predetermined value.
Amplifier for external loudspeaker.

Demonstration Amplifier for Schools† (Figure 2). An instrument having a variable circuit which may be used, in conjunction with various external instruments, for demonstrating audio-frequency circuit technique. The amplifier has many controls for altering the circuit from the front panel, and may also be used as a high quality amplifier giving 10 watts output at 1·5% total distortion, for an input of 0·1 volt.

Slow Speed Oscilloscope†. An instrument with a long persistence tube for investigations at frequencies between ½ and 100 c/s.

Figure 2. Demonstration Amplifier for Schools.

Brief Specification.

Built in D.C. amplifier. Sensitivity 100 mv. input for 2 cm. peak to peak trace.

Time base range ½ — 100 c/s.

Two beams electronically switched.

Provision for superimposing and altering the phase of the beams for distortion comparisons.

The instrument contains all the necessary auxiliary controls power supplies, etc.

Precision Power Supply†. A representative instrument is shown providing 200 volts at 50 ma. and providing stabilization to 0·003% for mains or load variations of 15%.

Stand 5

INDUSTRIAL DISTRIBUTORS (SALES) Ltd., INDUSTRIAL DIAMOND INFORMATION BUREAU, DIAMOND RESEARCH DEPARTMENT, 32-34, Holborn Viaduct, London, E.C.1

Drum Abrasion Tester † (Figure 1). Abrasion on discs depends considerably on the grinding radius R (varying as R^2 or R^3), but comparison tests had necessarily to be carried out on rings of different radius. The newly developed testing machine has a drum of 4 in. diameter and 4 in. length and is divided into 6 grinding rings of ½ in. width each. Three or

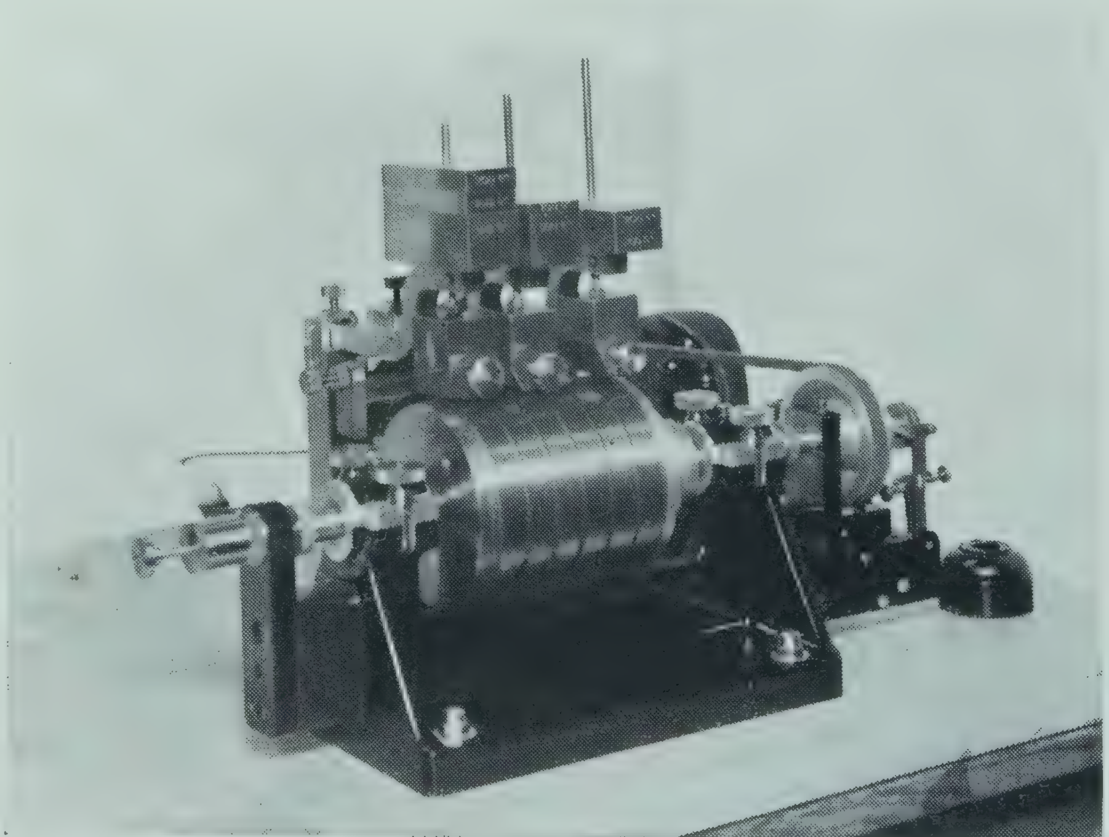


Figure 1. Drum Abrasion Tester.

more specimen holders can be operated simultaneously, but in general only one specimen will be tested at the same time. During the test the drum performs a slow reciprocating movement at a rate of 1 in. per 3 minutes. After this the direction of rotation of the feed motor is automatically reversed and the same operation repeated. It is, however, anticipated that in general only one pass of the specimen along the prepared drum surface will be made. The drum is of centrifugally cast iron of a Brinell hardness of about 280 kg/mm² (actually a specially turned cylinder liner has been used). The drum is mounted on a detachable spindle which can slide in two plain bearings. When removing the upper bearing cups the spindle can be taken out. The feed movement in axial direction is transmitted by co-axially arranged balls. The specimen holders of swan-neck form are suspended on a knife edge and held in equilibrium. The loading weights are directly applied over the specimen holder. The specimen holder consists of a support with two prongs moved in axial direction by right and left hand screw (British Patent 600,133). The drum is rotated by a $\frac{1}{4}$ H.P. A.C. motor with 800 to 1,000 r.p.m. respectively.

The test period is given by the reciprocating movement and should be one or more strokes. The drum surface of porous cast iron can be easily prepared with abrasives mixed with a vegetable oil, such as olive oil. DEMONSTRATION.

Micro-Macro Hardness Tester† (Figure 2). (British Patent Application.) This hardness tester has been developed on the following principles :

(*a*) Test pieces of arbitrary size and up to 5 in. height to be accommodated ; impressions can be made up to 2 in. from the edge, and more, in particular cases ; weights of specimens up to 20 lb. and more.

(*b*) Dead weight loading during test, but avoiding any shock action.

(*c*) Mechanical (loading) system and optical (viewing and measuring) system intersecting at a suitable angle on the surface of the specimen to be tested.

(*d*) All sensitive operations to be made automatically to be independent of the operator. Previously the loading time had to be determined by the operator, but it is now carried out by a process timer.

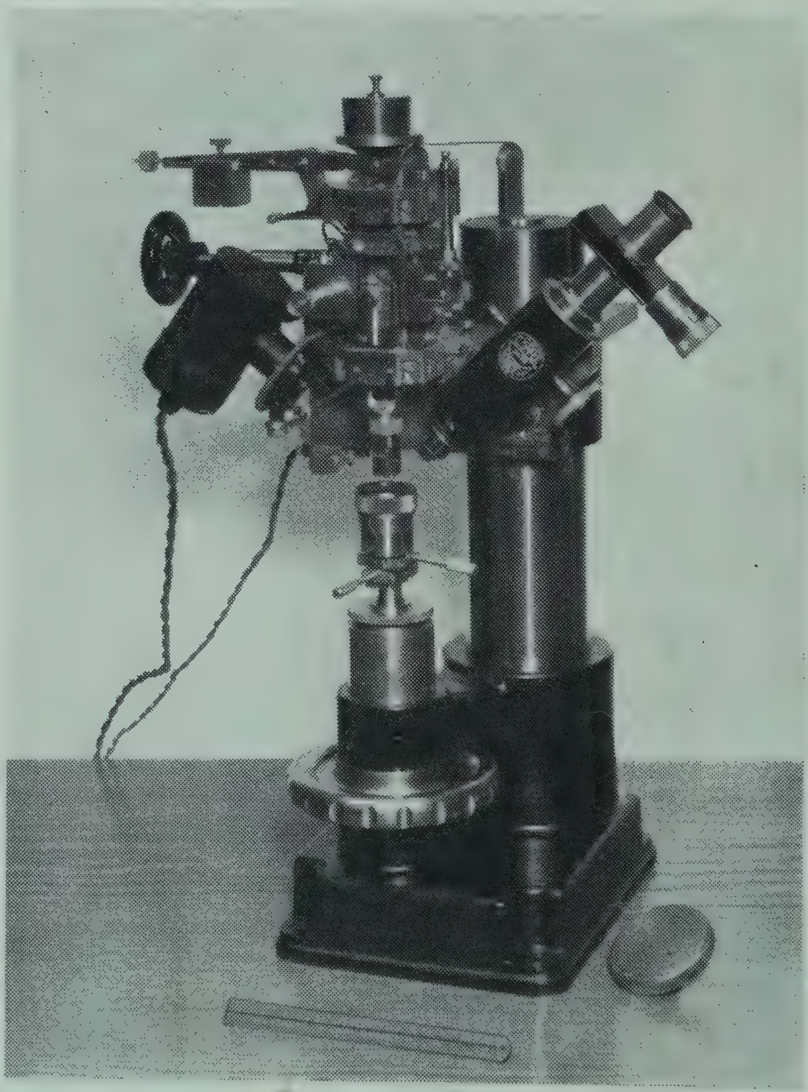


Figure 2. Micro-macro Hardness Tester.

The indentation length is measured with a microscope, the tube of which is arranged at about 45° to the test surface. This limits somewhat the use of high-power objectives, but a 2/3 objective can nevertheless be accommodated without difficulty. This, together with a 12× eyepiece gives a total magnification of about 150, which is sufficient in many instances. Higher magnifications can be

obtained by reducing the size of the sample. The actual measurement is carried out with an eyepiece screw micrometer.

Indenter. Double-cone indenter (British Patent Application) usually a double-conical diamond of 2 mm. radius and about 154° included angle, with the same mount as the standard Vickers Indenter (3/16 Whitworth thread) diamond adjustable through a range of ± 30 giving a large number of potential contact points. The tester can also be used with other hardness indenter points.

DEMONSTRATION.

Micro-Abrasion Tester† (Figure 3). The tester has been designed to investigate (*i*) wear and abrasion resistance of hard and brittle materials, (*ii*) properties of abrasives, (*iii*) influence of lubricants. (British Patent Application.)

The main parts of the apparatus are a power-driven speed-controlled grinding wheel, adjustable specimen holder, and a loading arrangement. The specimen is fixed at one end of a balance arm, the other end of which carries the weight. The balance arm is pivoted in ball bearing centres which are attached to a slide-system adjustable in three directions perpendicular to each other.

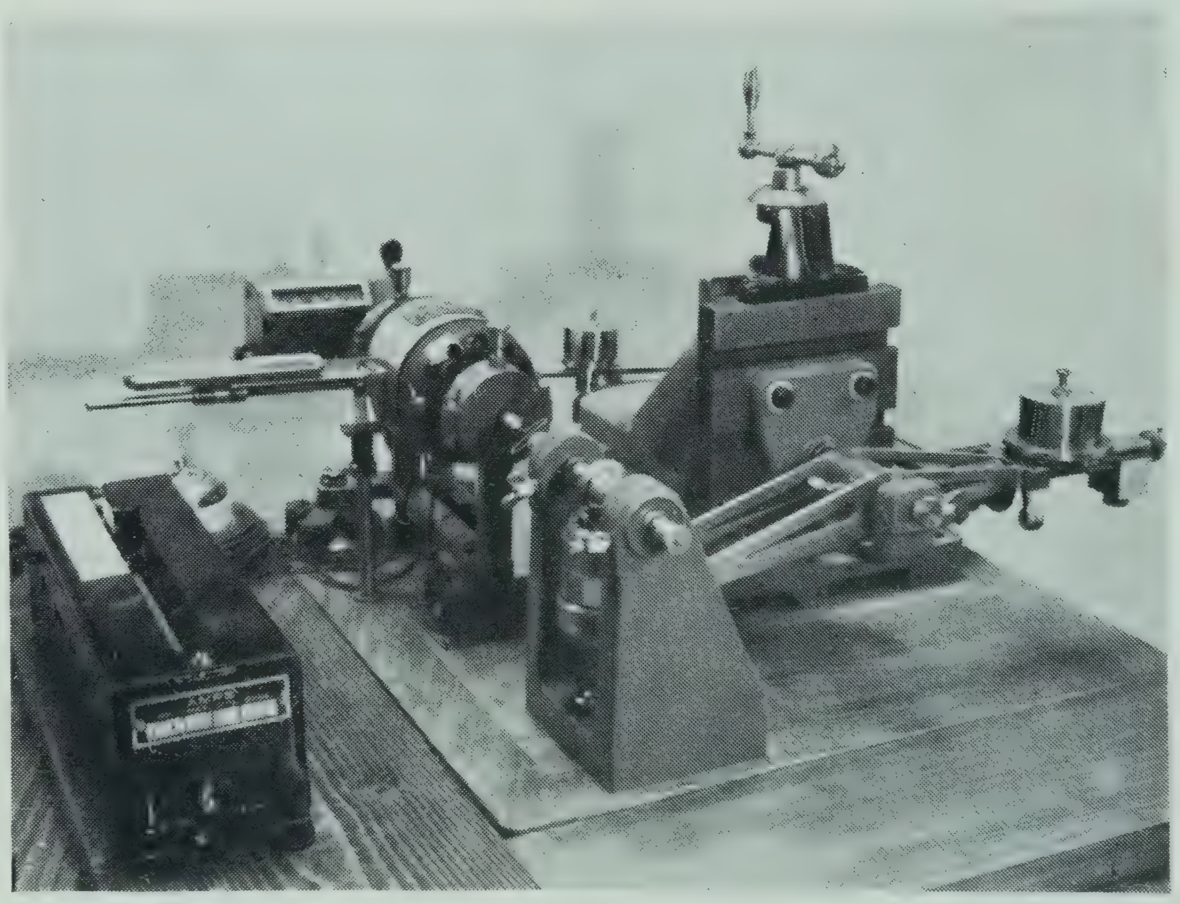


Figure 3. Micro-abrasion Tester.

The grinding wheel, for instance, a cast-iron disc with V-shaped periphery, mounted on a spindle between centres, is driven by an electric motor which is connected with the spindle through a wire loop. The motor is mounted as a pendulum and oscillates within limits around the rotating shaft, allowing the torque to be measured by a simple weight and lever arrangement. The speed of the motor is controlled by a rheostat and checked by a speedometer.

Special features are (*i*) The impression or cavity in the specimen is of very small size and can only be observed correctly under the microscope ; in this way, more than one abrasion mark can be made on a very limited surface, such as on diamond with a face of only 5·0 mm². (*ii*) Very light loads, just sufficient to obtain a well balanced condition of the apparatus, say between 20 and 500 gm., can be applied. (*iii*) Very high speeds up to 16,000 r.p.m. and infinitely variable can be applied ; the standard speed is 10,000 r.p.m. The tester has been successfully applied for producing abrasion marks on diamond surfaces. (*Nature, Lond.*, 1949, **164**, 193.)

DEMONSTRATION.

Diamond Tools. Industrial Distributors are not manufacturers of diamond tools, but give a survey of commercial diamond tools used for precision machining and for scientific purposes :

Shaped diamond tools for machining metals and non-metallic materials.

Hardness indenters. Rockwell cones and Vickers-Firth pyramids, and Knoop (Tukon) indenter. Double-Cone indenters (British Patent Application).

Shaped tools for truing thread-grinding wheels. Matrix cones and chisels, Newall cubes, etc.

Shaped points for surface testers. Talysurf, Tomlinson, Brush Analyser.

Shaped and polished diamond gramophone needles for light-weight pick-ups for 10,000 c/s. and more.

Rough diamonds for truing grinding wheels.

Diamonds for engraving on glass.

Examples of workpieces machined and treated with diamonds.

Stand 6

FIELDEN ELECTRONICS Ltd.,
Paston Road, Wythenshawe, Manchester

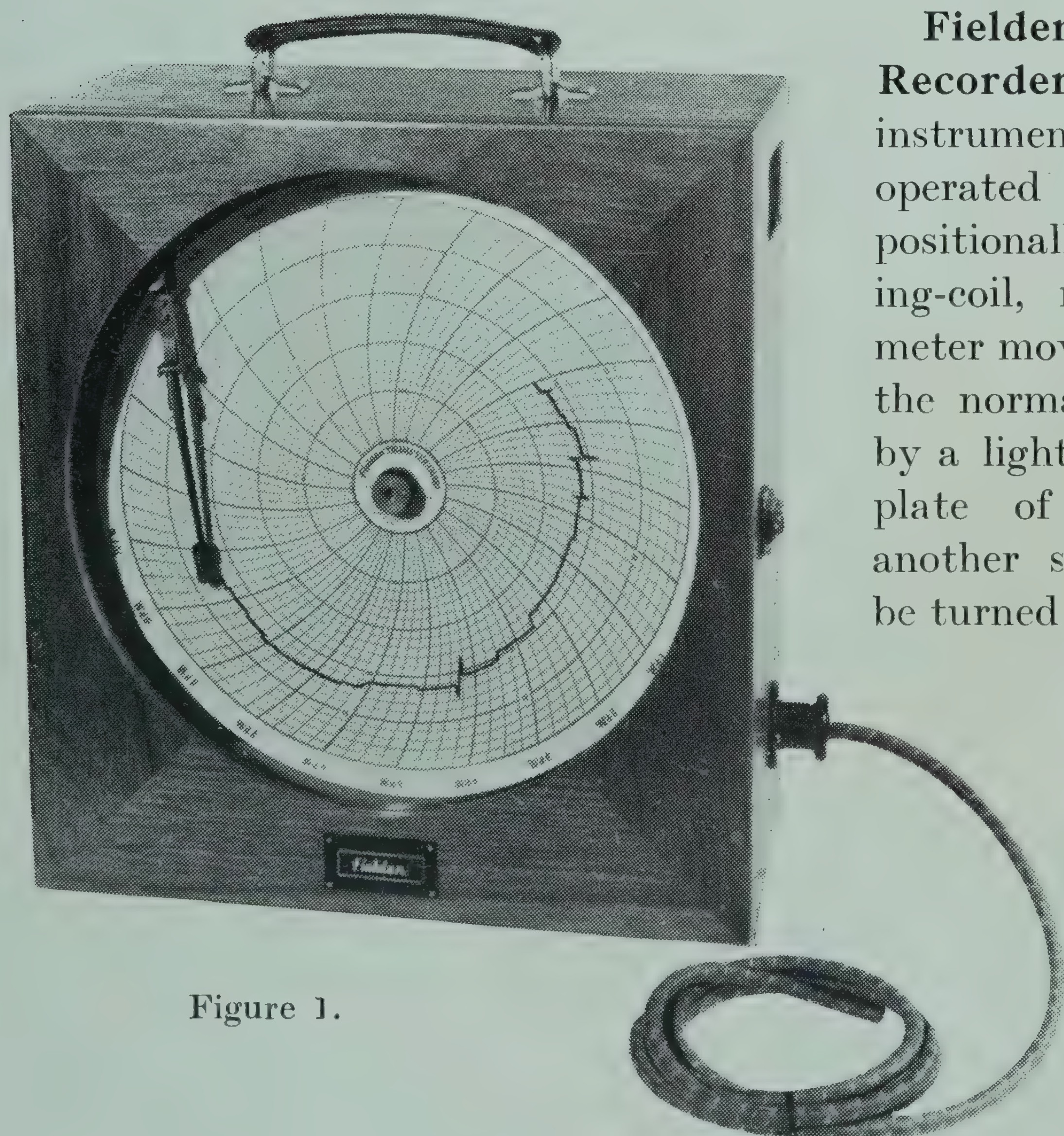


Figure 1.

Fielden Servograph Graph Recorder† (Figure 1). This instrument consists of a servo operated mechanism which is positionally controlled by a moving-coil, moving-iron or dynamometer movement. The indicator of the normal instrument is replaced by a light vane which acts as one plate of a variable condenser, another similar vane, arranged to be turned by the servo mechanism, moves in the same arc as the meter operated vane, and the two are maintained at a constant spacing by an electronic capacity relay which controls the servo motor. The current to be measured has to provide only enough energy to deflect a normal indicating meter movement and the servo mechanism locates the pen arm with precision at the resting place of the movement.

The equipment has been developed in rotary disc form and is available in several ranges of current, voltage and power. A further model providing a roll chart is under development and will be available in due course.

The instrument has the following outstanding features :

(1) The power required from the measured source is only of the order of a few microwatts for F.S.D., and it can be used in any circuit that provides enough energy to operate any normal indicating instrument.

(2) The instrument reproduces the accuracy of the basic meter movement used in its construction, and thus provides a graph recorder to B.S.I meter accuracy.

(3) The servo-operated pen arm removes the necessity of providing a flimsy pen mechanism, and the attendant pen troubles associated with many types of recorder are eliminated.

(4) The instrument will operate in any position in ships at sea or in any moving vehicle.

(5) The servo-operated pen mechanism removes all inaccuracies due to pen to paper friction, and vertical transients are recorded with accuracy.

(6) The servo mechanism provides ample power for the operation of cam switches for an alarm or control, and recorder controller models are available.

(7) The instrument has no external controls or adjustments and will operate without attention during the life cycle of the two valves employed in its electronic circuit.

The Fielden Proximity Meter† (Figure 2). The Fielden Proximity Meter, Type P.M.1. is a general utility instrument suitable for application to many problems in industrial control and measurement, finding particularly wide use in the engineering and allied industries for comparing, measuring or monitoring dimensions and distortions of an order not possible by mechanical means. In the latter field it completely surpasses any other method of micro-measurement as it is possible to carry out the operation without physical contact with the specimen ; thus wear and pressure inaccuracies are completely eliminated. In a wider field the instrument may be applied to any problem which can be resolved into a minute change in electrical capacitance relative to earth. This change may be produced either from a minute mechanical displacement or from a change in dielectric properties.

Figure 2.

The instrument indicates any change in the capacitance of a metal electrode which can be fitted to terminate the radio-frequency coaxial cable which forms an integral part of the instrument.

The approach of any substance, conductor, insulator, solid or liquid will change the capacitance of the terminating electrode, and this change is recorded on the meter. The Set Zero control knob enables the effective electrode capacitance to be balanced to zero at any value, and the other control knob adjusts the sensitivity of the equipment over a wide range.

Electronic Hygrometer†. The Fielden Electronic Hygrometer gives a direct and accurate visual indication of relative humidity at any normal atmospheric temperature, without any of the inherent disadvantages of other methods. The technique employed is the result of long-term specialized research in this branch of physics, and the equipment represents a perfect electrical analogy of the two bulb hygrometer, with the advantage of very small electrical resistance elements which vary to a marked degree with changes in temperature and consequently give almost immediate response to any change in R.H. value. Three of these resistance elements are used, two dry and one wet. One dry and one wet perform the function of a normal wet and dry bulb hygrometer, and the second dry bulb is arranged in a special circuit which compensates for changes in ambient temperature.

The equipment is available as an indicator, as an indicator controller, or as a graph recorder controller. It is completely fool-proof, has no external adjustments or controls and will give long term trouble free service.

Tektor Proximity Switch† (Figure 3). The Tektor consists of an electrical relay operated by electronic equipment which is sensitive to a minute change in electrical capacitance. The circuit is so designed that the change in capacitance can be effective at the end of a length of coaxial cable. This cable is terminated by a ferrule from which protrudes a short length of 4B.A. screwed rod to facilitate the fitting of a suitable electrode.

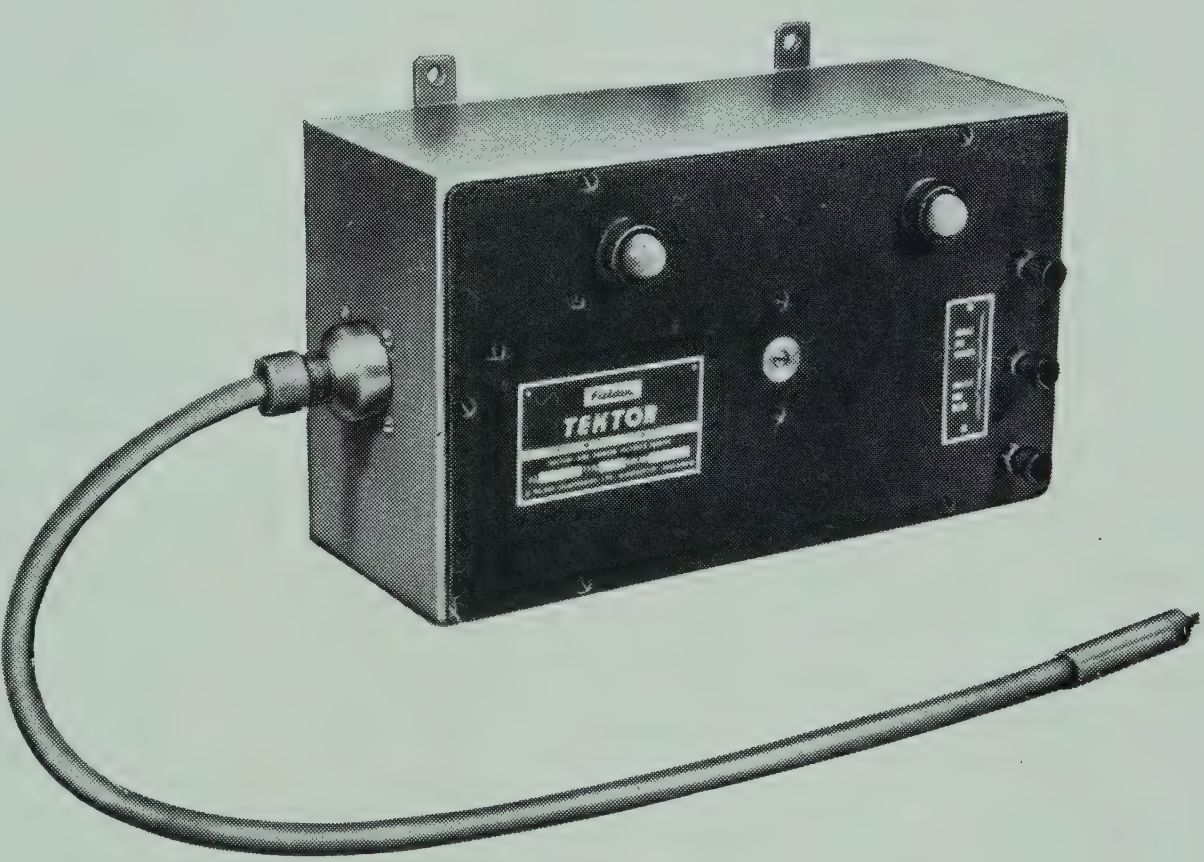


Figure 3.

The circuit is phase sensitive and the relay will operate either with the approach of any conducting material to the terminating electrode or by the entry of any insulating material into the electric field surrounding the electrode. Thus the equipment is sensitive to the approach of any liquid or solid matter or to a gas where free ions exist (e.g., a flame). The operational distance of the relay is determined by (1) the size and geometry of the terminating electrode, (2) the volume and composition of the approaching matter, (3) the setting of the control knob on the instrument. Example : if the cable is terminated in a small metal bar 3 in. long the relay will operate when the human hand approaches within 3 in.

The relay fitted in the equipment is arranged to alternate two coloured signal lamps on the panel of the instrument, and to operate a single pole change-over switch connected to three terminals on the front panel. The contacts of the relay are suitable for alternating currents up to 0·3 amperes and voltage up to 250 volts.

Stand 7

MUREX Ltd.,
Rainham, Essex

Samples of Tantalum Metal†, now being made for the first time in this country, are being shown. The resistance to attack by most chemicals combined with high mechanical strength and thermal conductivity make tantalum particularly suitable for the construction of certain types of equipment. Its use in the electronic industry is also well known.

Tantalum was formerly produced by one firm in the United States of America and by a second in Germany, but since the war has been available only from America. In view of the prevailing world economic situation, design engineers have been encouraged to use alternative materials, and only very limited quantities have been imported.

Production of tantalum metal at Murex is now being put on a regular basis, though it has not yet reached full capacity. At the time of going to press it is not possible to give full technical details of the materials which will be available, but on the occasion of this exhibition the opportunity will be taken of discussing with engineers their probable future requirements, especially as to sizes, types of material and specification.

It is intended that production at Rainham shall cover the whole range of sizes of sheet, wire and bars used in the electronics industry as well as in chemical plant and for surgical work.

Samples of tungsten and molybdenum metals are also being shown, the exhibits including examples of the more unusual forms, that is, the exceptionally large and the thin sheets which have lately been developed.

Stand 8

ELECTRONIC INSTRUMENTS Ltd.,
17, Paradise Road, Richmond, Surrey

Surface Temperature Indicator, the Dynatherm†. A new instrument for indicating and measuring the surface temperatures of rapidly rotating or moving bodies within the range of 200° to 1000°C. A lead sulphide cell is used in the pick-up head and indications are shown on a cathode-ray tube which may be scaled in degrees Centigrade. The whole apparatus is designed to be portable and will work off mains or a low tension battery. It has been developed in conjunction with Ferodo Ltd.

Self Monitoring Electrometer. A new method of providing a permanently stable D.C. amplifier by periodically referring the input to an inherently stable reference level and automatically adjusting the characteristics of the amplifier to cancel out any residual errors. The apparatus is shown coupled to a self-

balancing potentiometer which ensures continuity of indication during the monitoring period. An important application of this principle lies in the field of pH measurement. (Figure 1).

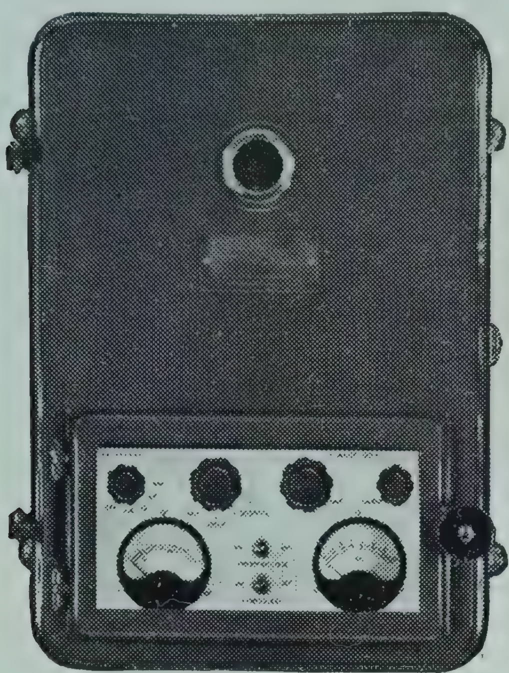


Figure 1.

Figure 2.

Laboratory Valve Voltmeter, Model 26†. An instrument specially designed for the physicist and research worker. It sets a new standard of accuracy in Valve Voltmeters and covers from 0·2 v. to 250 v. on both A.C. or D.C. The specification includes four resistance ranges and a probe for R.F. measurements. A six-inch mirror scale meter is a special feature. (Figure 2).

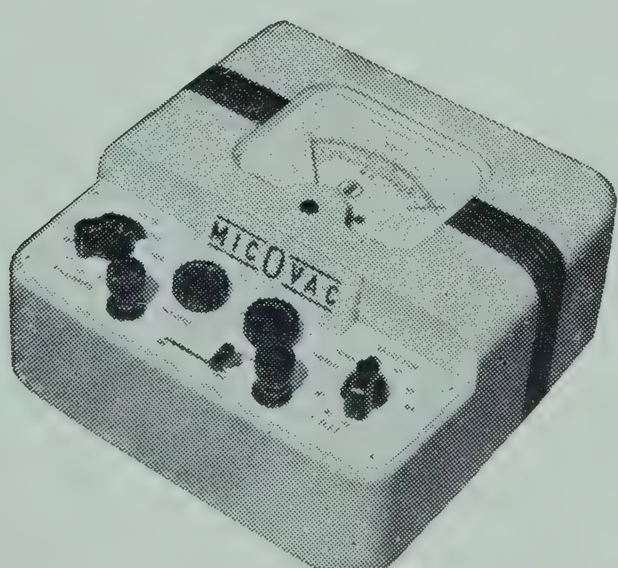


Figure 3.

Figure 4.

Electronic Test Meter, the Micovac†. A versatile battery operated multi-range test meter which measures D.C., A.F. and R.F. voltages up to 500 volts. Resistance ranges and current ranges are also included, and multipliers are available to extend the range to 5000 volts D.C. A handy carrying case ensures complete portability. (Figure 3).

Substandard Multi-range Test Meter, Model 44†. A precision laboratory instrument covering the range from 1 ma. to 10 amps. and 1 volt to 1000 volts on D.C. or A.C. The accuracy is *substandard* on all D.C. ranges and within 0·5% on A.C. A patented moving-coil cutout of unusual design ensures complete

protection in the event of accidental overloads. The Model 44 is especially useful for calibrating first grade single or multi-range meters. (Figure 4).

Figure 5.

Figure 6.

Twenty Million Megohmmeter, Model 29†. A general purpose instrument covering a range of 300,000 ohms to 20,000,000 megohms in seven decades. Two test voltages, 85 volts and 500 volts, are available and provision is also made for an external D.C. battery supply. A special feature is the ease of operation which makes the instrument suitable for production testing as well as for laboratory work. (Figure 5).

Millisecond Meter, the 'Chronotron' Model 25C†. A new instrument designed for measuring time intervals extending into the microsecond region. The instrument covers the following ranges :—0-40, 0-100, 0-400 microseconds, 0-1, 0-4, 0-10 milliseconds ; it operates from a square-wave input or from external contacts applied to a probe. An accuracy of 3% is obtainable on the shortest range. (Figure 6).

Stand 9

EVANS ELECTROSELENIUM LTD.,

Harlow, Essex

The 'EEL' Universal Densitometer† is an instrument of robust design intended for routine measurement of the optical densities of photographic films. Three aperture sizes are provided and readings may be made on wet or dry negatives up to densities of three on three ranges.

The Reflection Head is an accessory which plugs into the Universal Densitometer to enable reflection densities of sensiometric strips or positives to be measured. On black and white measurements, two ranges 0 – 1, 1 – 2 are available and in addition tri-colour filters are provided for measurement of three colour separations.

The 'EEL' Opacity Meter† is an improved reflectometer with precise linear characteristics which, when used with black and white standards, enables the

opacity or 'covering power' of opaque films, papers or plastics to be readily measured.

The 'EEL' Abridged Reflectance Spectrophotometer† is an instrument to measure the reflectance of a sample in eight narrow bands of the spectrum. Readings may be readily made and used to assess, for example, the 'off whiteness' of the sample or to compare the spectrum characteristics of various colours. The sample is illuminated at 45 degrees and viewed normal to the surface. Accuracy of measurement is approximately to within 1%.

The 'EEL' Nephelometer† is designed particularly for routine measurements of the growth of a bacteriological culture in a test tube by photoelectric means. Any of the usual types of culture tubes may be employed in the instrument, which is calibrated by reference to a standard.

The 'EEL' Absorptiometer† is a simple yet accurate instrument, which meets all requirements of colorimetric analysis. The instrument will take standard optical cells of any length up to 10 centimetres and measurements may be made with narrow band spectrum filters. Mains stabilization is provided, and readings are given on a robust 4 in. meter.

Stand 10

INDUSTRIAL ELECTRONICS,

99, Grays Inn Road, London, W.C.1

Portable Audio-Frequency Response Curve Tracer Model 1900† is designed for the measurement and checking of audio-frequency apparatus such as amplifiers, filters, loudspeakers, transformers, etc. The response curve of the apparatus under test is displayed on the calibrated face of a long afterglow cathode-ray tube.

The instrument consists of a beat frequency oscillator with automatic frequency sweep coupled to a cathode-ray system arranged to give a deflection on the horizontal axis proportional to the logarithm of the frequency. The beat-frequency oscillator output is also supplied to the apparatus under test, and subsequently to a rectifier system which deflects the cathode-ray tube spot in the vertical axis.

The frequency scale of the instrument is logarithmic but the rate of deflection is approximately linear, resulting in a rate of frequency change which increases continuously with increasing frequency.

The instrument is entirely electronic in operation. DEMONSTRATION.

Portable Audio-Frequency Visual Wave Analyser Model 1950† consists of an automatic frequency sweep beat-frequency oscillator and a similar display system to that in Model 1900. In this instrument the beat-frequency oscillator output is combined with the wave to be analysed in a mixer stage which produces a pulse as the oscillator frequency passes through zero beat with each harmonic in turn. The pulses are displayed in order of frequency, height indicating amplitude. DEMONSTRATION.

Portable Oscilloscope Model 1200B† is a compact general purpose instrument with features which are of particular interest to the physicist. It has X and Y axis amplifiers which are D.C. connected, giving amplification with no phase shift down to zero frequency. The time-base frequency may be extended down to cycles per minute if desired. DEMONSTRATION.

Stand 11

DYNATRON RADIO Ltd.,

Perfecta Works, Ray Lea Road, Maidenhead, Berks.

Electronic Equipment for use in Nuclear Physics, Electro-Medical or Industrial Research (sold under licence of the M.O.S. who were responsible for development of original circuits).

Scaling Unit Type SC200†. 22-valve counting unit for use with Geiger-Müller Tube or Ionization Chamber via Amplifier/Discriminator. The unit is rack mounting and completely self-contained with its own power supplies and mains interference suppression.

The input circuit can be switched for counting from : (i) Ionization Chamber Amplifier/Discriminator: the recovery time of the scaling unit in this condition is less than 6 microseconds, i.e. pulses spaced by more than 6 microseconds will be individually counted. (ii) Geiger-Müller Tube : in this condition an adjustable 'paralysis' time in the range approximately 0·3 to 1·0 millisecond is introduced to avoid 'multiple' counts.

The input sensitivity of the Scaling Unit is 5 volt pulse positive or negative for I.C. counting, or 3 volt pulse positive or negative for G-M counting. Counts up to 100 are indicated by miniature neons arranged in two banks – tens and units – and counts up to 1,000,000 are recorded mechanically by G.P.O. telephone call meter in hundreds. The maximum counting speed of a single Scaling Unit is 500 per second, but this can be extended considerably by the use of two Scaling Units in series.

At low speeds the mechanical counter can be switched in to record every 10 counts up to 50 per second, or every count up to 5 per second. Counting and re-setting after count can be operated from front panel or by remote control unit.

Probe Unit Type PR.200†. A compact amplifier with gain adjustable up to × 25, for mounting close to Geiger-Müller Tube in lead 'castle' and enabling the Tube to be situated up to 12 feet away from the Scaling Unit. The high voltage supply for the Tube is fed from the Stabilized E.H.T. Unit via a resistor situated in the Probe. Pulses developed across this resistor are fed to the amplifier via a high insulation D.C. blocking condenser. The amplitude pulses are passed on to the Scaling Unit via 6-way cable. Power supplies for the Probe are drawn from the the Scaling Unit.

Power Unit P.200†. Rack mounted and self-contained with mains interference suppression, this unit provides an accurate and stabilized supply of E.H.T. for the operation of Geiger-Müller tubes. Output can be switched to be positive

or negative with respect to chassis, and the voltage is continuously adjustable up to 4kv. in 4 ranges viz. : 200-500, 400-1,000, 800-2,000 and 1,600-4,000.

Hum present in the output is less than 0·4v. peak to peak on highest range and less than 0·15v. peak to peak on other ranges.

A 10% change in mains input voltage produces less than 0·66% change in output volts.

Monitor Oscilloscope Type M200†. A self-contained rack mounting oscilloscope with D.C. coupled Y amplifiers and Cathode Follower Probe for monitoring in discriminator circuits, etc.

The amplifier frequency response is ± 1 db. up to 1 Mc/s. and less than 3 db. down at 3 Mc/s. ; the probe input capacity is less than 20 pF.

The time-base may be self running (50 c/s. to 50 kc/s.) or triggered from external positive or negative pulses (sweep speeds 15 microseconds to 30 milliseconds).

A range of cabinet racks in various heights has been produced for mounting all the above equipment.

Stand 12

PANAX EQUIPMENT Ltd.,

347, London Road, Mitcham, Surrey

Model 44. Geiger-Müller Counting Equipment†. A self-contained instrument for hospital or laboratory use. A simply-operated instrument for A.C. mains, the unit has a stabilized E.H.T. supply and is an improved version of the Model 22. An impulse register may be switched to give scales of 8, 16, 32 or 64. Neon interpolation lamps are provided and the scales of 2 are designed for maximum reliability. It is of robust construction, with fully standard components and is finished in a durable heat resisting cream plastic. An E.H.T. meter provides continuous monitoring of the G-M voltage, which is variable from 0-2,000 volts.

Model 40A. Portable Rate-of-Count Geiger-Müller Monitor†. A mains-operated instrument with a rate-of-count indicator and loudspeaker amplifier for the rapid location and measurement on benches etc. of radioactive sources. It can also be used effectively for general assay work. The instrument is housed in an attractive case with carrying handle and is finished in durable cream plastic. The standard unit is supplied with a G.E.C. Type GM4 tube with an end window of duralumin of 6 mg. per cm^2, but an EHM2 tube with mica window can be supplied if required. The weight is 22 lb. and the ranges provided are of 0-1,000, 0-10,000 and 0-50,000 counts per minute.

Model 33. Battery-operated Portable Hand-grip Geiger-Müller Counter†. A small portable instrument for the detection of radiation in the laboratory or field. Audible indication is given by lightweight headphones. A single standard portable-radio battery of long life supplies the tube and amplifier voltages. A control enables the G-M voltage to be varied up to 1,600 volts and compensates for ageing batteries. A GM2 duralumin end-window tube is fitted as standard but alternative mica-window tubes can be supplied for special laboratory work. The instrument is robust and has a pistol-grip handle. Overall dimensions are $10\frac{1}{2}$ in. × $3\frac{3}{4}$ in. × $2\frac{3}{4}$ in. ; weight $3\frac{1}{4}$ lb. The price is low.

Stand 13

ACCLES & POLLOCK Ltd.,

Oldbury, Birmingham

Specialised Tubing for Industrial Precision Instruments including Laboratory, Research and Medical Apparatus†.

The application and development of high precision tubes for modern scientific instruments and apparatus form a highly specialized branch of the work of Accles & Pollock Limited of Oldbury, Birmingham. This firm is in a position to supply advice on problems covering metallurgy, welding, heat treatment, tube manipulation technique, corrosive resisting properties of various alloys and to carry out research to meet special requirements of enquirers in connection with the use of tubes and tubular components for instruments.

The following examples of tubes which have been developed in the instrument field will serve to indicate both the scope and the value of technical information available to instrument manufacturers.

Bourdon Tubing†. The application of the Bourdon Tube covers a wide range of instruments including pressure, compound, vacuum, and duplex gauges, pressure recorders and controllers, level controllers, liquid content gauges, expansion type thermometers with metallic systems, chronometric radio-sondes (Olland Cycle) etc.

The shape of the tube itself, the form that the tube is bent into and the material used, all depend upon the application and conditions under which the apparatus is to work.

(*a*) *Tube Section* (*or shape*). For high pressure work the tube is supplied round, the two ends are screwed and the centre portion is normally sectioned to an oval shape to obtain the requisite deflection.

For low pressure gauges, tubes are normally sectioned the full length to an oval shape or flattened leaving a small gap in the bore often as small as 0·002 in.

The range of tube thicknesses varies mainly between 0·006 in. for low pressure work, up to $\frac{1}{8}$ in. for high pressure hydraulic gauges. The range of tube diameters or equivalent diameters for sections varies mainly from $\frac{1}{8}$ in. o.d. up to 1 in. o.d. (Figure 1).

Figure 1.

(*b*) *Bent Shape of Tube.* The Bourdon Tube can be the normal ‘ C ’ shape, that is half or three quarters of a turn, or of the multiturn type. The latter can be

either helical or the flat 'main-spring' multiturn form. This type makes use of the flattened section tube where a large deflection is required for a small variation in pressure i.e. in expansion or pressure thermometers, liquid content gauges etc.

(*c*) *Bourdon Tube Material.* The use of non-ferrous alloys mainly phosphor bronze, is confined to the manufacture of medium and low pressure gauges. This is due to the fact that these particular alloys cannot be heat-treated to give the necessary mechanical properties required for high pressure work.

In conjunction with gauge manufacturers Accles & Pollock Ltd. have developed a chrome molybdenum steel of a specially selected analysis which will meet the stringent requirements of pressure gauge and instrument manufacturers in case of manipulation combined with the necessary mechanical properties after heat-treatment. This tubing is specially processed from the billet stage to minimize fissuring in the bore.

This tubing can also be used for low pressure work without heat-treatment. Certain gauge manufacturers are using an oval section tube of this specification of an equivalent outside diameter size $\frac{9}{16}$ in. and a thickness of 0·006 in. for pressure of 5-10 lb/in^2, the work hardening properties of the material being sufficient to give it the required mechanical strength without heat treatment.

Non-ferrous alloys are gradually being replaced by steel as the prejudices against steel are broken down.

Martensitic and Austenitic Stainless Steel Bourdon tubes are occasionally used to resist corrosion under certain conditions.

Capillary Tubing†. (Figure 2). Capillary Tubing is mainly used for the transmitting of pressure from the pressure source to the instrument being used. The transmission medium can be of either liquid or gaseous form.

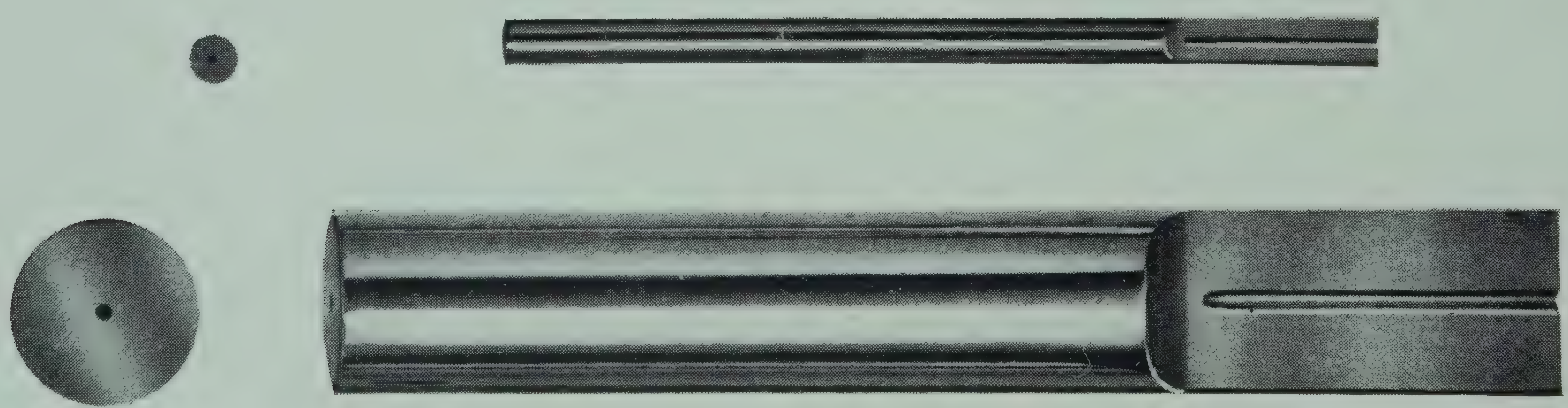


Figure 2.

Material used in its manufacture varies with the type of instrument and the conditions under which the system is to work. Usual materials are copper, cupro-nickel and mild steel, but other alloys such as stainless steel are occasionally used for special purposes.

The production of a clean bore, free from fissures and foreign matter, has been a major problem in the past; but present day methods with modern equipment and special technique have minimized this difficulty.

Capillary tube lengths vary depending upon the distance of the instrument from the source of pressure, but these are limited by the transmitting medium. The maximum length for compensated liquid-filled systems is in the vicinity of 150

feet. Vapour pressure and gas-filled systems have been made with capillary lengths up to 400 ft. or more, but such long lengths usually present difficulty in installation. From the tube manufacturer's point of view, maximum lengths are limited by the size and accuracy of the bore required.

Special Capillary tubing with a wire core is supplied to one instrument manufacturer. The annular space between the core and the tube is equivalent in area to a bore diameter of 0·003 in. accurately controlled to limits of $\pm$0·0005 in. Lengths supplied vary between 50 and 100 ft.

Composite Capillary tubing is another Accles & Pollock speciality. (For details see separate heading 'Composite Tubing.')

Pointer Tubing†. Extremely fine bore thin-walled aluminium and aluminium alloy tubing is supplied in various tubular shapes and sizes for the manufacture of Instrument Pointers where a low moment of inertia combined with strength is an important consideration.

Tube sizes as small as 0·010 in. o.d. with a wall thickness of 0·001 in. are included within this range.

Composite Tubing†. The need often arises for tubes to be used where corrosive conditions in the bore are different from those outside and a material cannot be found to resist both conditions. Problems of this nature can be overcome with the use of a composite tube. This consists of two tubes made from different materials one drawn tightly over the other. Almost any combination of metals can be used but certain factors such as heat-treatment must be taken into consideration when choosing materials.

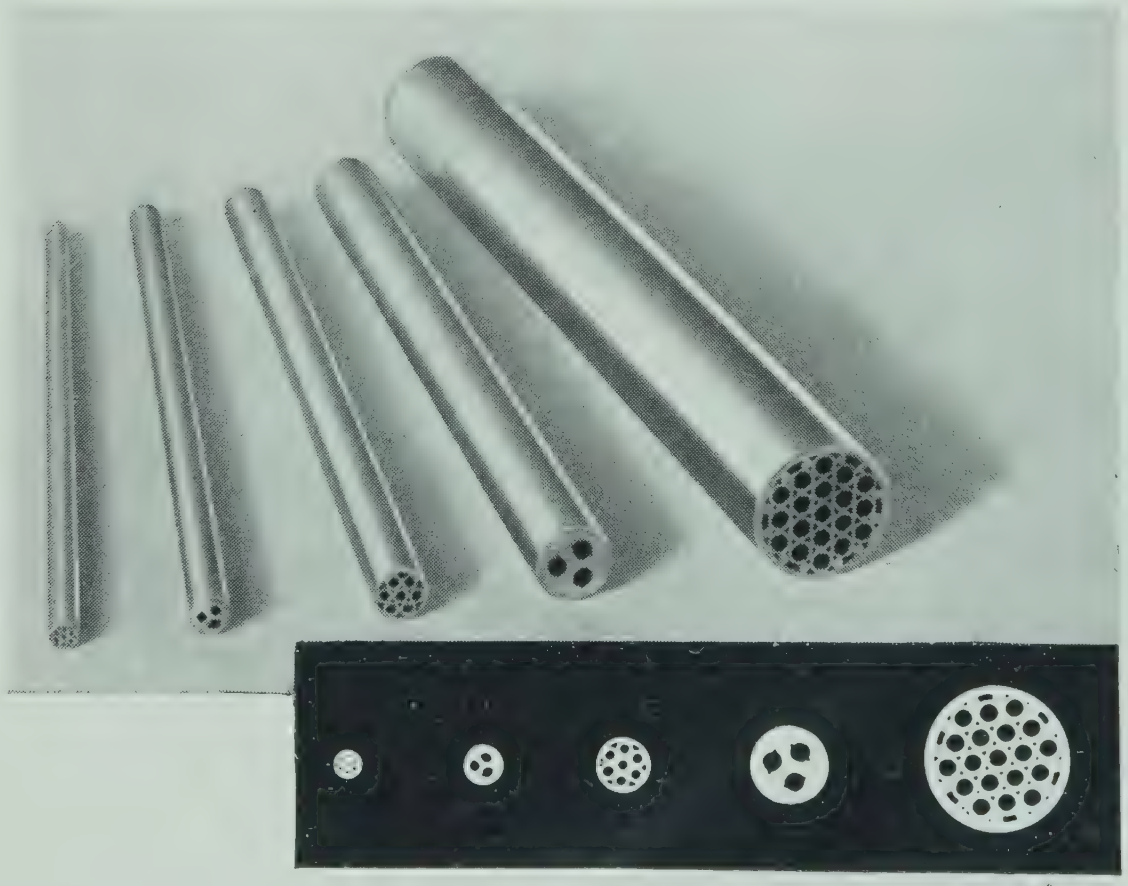


Figure 3.

Multibore Tubing†. (Figure 3). A Multibore Tube is a tube containing more than one hole. The development of this range of tubing is proceeding rapidly to cater for the growing demand by firms engaged on gas and liquid ejector and

heat exchanger research. The following few sizes indicate the wide range now covered in various alloys :—

0·125 in. o.d. × 2 holes	0·188 in. o.d. × 3 holes
0·050 in. o.d. × 3 holes	0·171 in. o.d. × 7 holes
0·110 in. o.d. × 3 holes	0·447 in. o.d. × 19 holes
0·125 in. o.d. × 3 holes	0·500 in. o.d. × 50 holes

Miscellaneous Tubing†. The following list briefly details a few of the general applications of tubing :

(1) Tubing for sheathing thermometers and thermocouples in various alloy steels depending upon the required corrosive resisting properties and temperature range to be covered.

(2) Special Monel Tubing with a bore of approximately 0·005 in. to 0·010 in. in lengths of up to 100 ft. for aircraft de-icing equipment.

(3) Tubing with a bore as small as 0·006 in. for use in series with various types of pressure operated instruments to enable steady readings to be obtained of a pulsating pressure. The tube is often used in the form of a small coil or a short length fitted inside the pipe coupling to the instrument.

(4) Venturi tubes for the manufacture of pressure type flow meters including aircraft speed indicators.

(5) Tubing for the thermometer ‘ pocket ’ used in pressure type thermometers with metallic systems. The selection of the thickness and material for this purpose is governed mainly by corrosion resistance and thermal conductivity.

(6) Pitot and Static tubes for Speed Indicator instruments used in aircraft and wind tunnel tests. The ‘ Yawmeter ’ used in measuring airflow past a model is also made from tubing.

(7) Special process, hardened and tempered martensitic stainless iron tubing 0·100 in. o.d. × 0·008 in. i.d. for research work at extremely high pressures up to 150,000 lb/in^2.

(8) Tubing 1 in. o.d. × 0·004 in. thick for heat exchanger research work.

(9) Special tubing used in Surgery such as the Smith-Peterson tubular nail. Hypodermic needle tubing is an important speciality falling in this group. Sizes from 0·008 in. o.d. upwards are supplied ; materials including austenitic stainless steel, pure nickel and high carbon steels.

(10) Small bore stainless tubing used by Orthodentists in the manufacture of teeth straightening devices.

Stand 14

THE RESEARCH AND DEVELOPMENT DEPARTMENT THE DISTILLERS COMPANY Ltd.,

Great Burgh, Epsom, Surrey

Magnetic Oxygen Recorder. This meter has been developed for measuring the oxygen content of gases and in contrast to the magnetic oxygen meter developed in Germany, the calibration of this meter is not materially dependent on the nature of other gases present provided that paramagnetic gases such as NO_2, NO, ClO_2 are absent.

The instrument uses the Faraday method of measuring the volume magnetic

susceptibility of a gas, which in these circumstances is a function of the oxygen content.

A small quartz test piece is mounted on a torsion fibre in a strong inhomogeneous field. The force acting on the test piece is a function of the magnetic susceptibility of the gas surrounding the test piece. The movements of the test piece are amplified by an optical lever, twin-cathode photocell and a direct coupled twin-triode amplifier. The output from the twin-triode amplifier operates an indicating meter and a recorder.

The response time of the instrument is 15 seconds. The instrument can be made with sensitivities of from 2% to 100% O_2 for full scale deflection. However with 2% full scale deflection the question of the diamagnetic susceptibilities of the other gases in the mixture becomes important.

The long term stability is good and the meter is free from zero drift. It has been in use for some time under plant conditions.

Stand 15

NAGARD Ltd.,

245, Brixton Road, London, S.W.9

Amplitude Modulated Carrier Frequency D.C. Amplifier, Type 103/A1†. Frequency range D.C. to 2·0 Mc/s., gain 30,000, output 300 volts peak to peak working into 5000 ohms, noise level 60 microvolts. This amplifier consists of a balanced converter stage which converts the input signal variations into proportional modulation of a carrier frequency. The output of this stage is fed into a carrier frequency amplifier employing tuned anode loads where substantially all the amplifications takes place and which is inherently stable and unaffected by mains variations. The amplified input signal without the carrier frequency, after rectification in a paraphase circuit, is fed to the grids of a balanced push-pull output stage. The limitation of the amplification in this type of amplifier is the noise level. DEMONSTRATION.

Amplitude Modulated Carrier Frequency D.C. Amplifier — Industrial Model, Type 103/A3†. Frequency range D.C. to 20 kc/s. This amplifier employs substantially the same principle as the type 103/A1 amplifier but with lower noise level corresponding to the 20 kc/s. limit to the frequency response. DEMONSTRATION.

Negative Feedback D.C. Amplifier, Type 103/A2†. Frequency range D.C. to 10 Mc/s., gain 1000, output 200 volts peak to peak working into 2000 ohms. DEMONSTRATION.

Oscilloscope and Oscillometer, Type 103†. This instrument is a general purpose oscilloscope and, like other oscilloscopes, is applicable to universal servicing and the usual comparative measurements. In addition to the qualitative measurements, however, it is capable of measuring quantitatively time, frequency and voltage from D.C. to 10 Mc/s. with accuracy. A main feature is the unit construction. The instrument is divided into two cases, each of easily portable nature. One case contains the Cathode-Ray Tube and controls, and is arranged

to accommodate, in removable form, unit assemblies, such as Time Bases and Amplifiers with various performances, Beam Switches for double and multiple traces, and special units. The other case contains the power supplies needed to provide accurate potentials, both D.C. and A.C., to the tube, time base, amplifier units, etc. (see Figure). Both present and future requirements are catered for on a liberal scale.

Time Bases are calibrated in frequency and time to an accuracy within 2 per cent, with linearity within 1 per cent. They are exceptionally good synchronizers, and suitable for continuous, triggered and single sweep operation. Amplifiers, types 103/1, 103/2 and 103/3, are D.C. amplifiers identical to the amplifiers previously described. All amplifiers are calibrated in volts to an accuracy of within 5 per cent and the output is balanced, giving a clear trace across the whole surface of a 6 in. cathode-ray tube.

Accessories : H.F. probe ; U.H.F. attachment for probe, effective up to 200 Mc/s.

DEMONSTRATION.

Standard Camera†, using 35 mm. film, for Type 103 oscilloscope.

Universal Mounting Table†. This is a light-weight adjustable table $21\frac{1}{2}$ in. $\times$ $10\frac{1}{2}$ in. suitable for all makes of portable oscilloscopes and instruments of similar size. Continuous adjustment of vertical tilt (25° up to 8° down) and easy movement in horizontal plane on rubber wheels are provided. The position of the tilting mechanism ensures stability of the instrument on the table at all angles.

Electronic Strain Gauge Measuring Head, Type W1†, to measure accurately minute displacements — less than 1 micron to 5000 microns — by a combination

of the gauge head with a D.C. amplifier type 103/A3. DEMONSTRATION.

Deflection Modulated Cathode-Ray Valves.
Signal Converter Type S.C.1.
Signal Converter Type S.C.2.
Frequency Multiplier Type F.M.1.

Stand 16

ELECTROTHERMAL ENGINEERING Ltd.,
270, Neville Road, London, E.7

Mercury Diffusion Pump Heater†. This new heating equipment has been developed using the well-known principle of Electrothermal Heating Mantles. The construction of this Heater consists of a knitted glass fabric to which is attached a coiled coil Heating Element insulated by glass fibre. Heat losses are overcome by the use of layers of glass wool insulation and the whole is contained in a closely knitted glass fabric, having at the point of flask entry a stainless steel spring device ensuring the closest possible adhesion to the whole flask surface. This eliminates any additional supporting equipment. Rapid heating is, therefore, obtained with a complete absence of bumping due to the complete element coverage of the flask up to mercury level. A Mercury Diffusion Pump with this new Heating Equipment will be shown in operation. DEMONSTRATION.

Stadler Still Heater†. This equipment is of similar construction to the Mercury Diffusion Pump Heater but is designed to accommodate a spherical shaped flask and has a high loading to give an output in excess of 2 litres per hour. This equipment will also be shown in operation. DEMONSTRATION.

Miniature Snap Action Thermostat†. This Thermostat, free of radio interference, incorporating a Miniature Permanent Magnet, will be shown in conjunction with a new flexible type of

'Waterproof Resistance Cord'† which is insulated with a plastic compound.

Stand 17

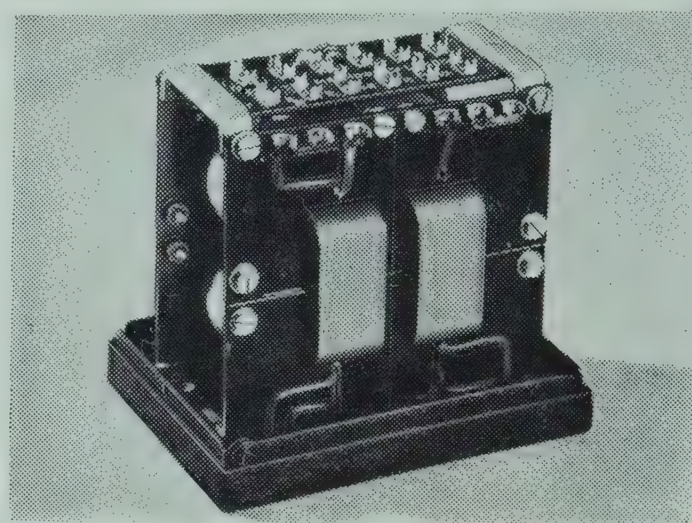
ELECTRO METHODS Ltd.,
220 The Vale, London, N.W. 11

Magnetic Amplifiers. These devices are particularly suitable for problems such as measurement control through very small D.C. signals. The input may be derived from photocells, thermocouples, bridge circuits, leakage currents, etc.

Magnetic Amplifiers can be cascaded in two or more stages. They can be combined with commercial electromagnetic relays to give a highly sensitive amplifier relay combination. They are also an essential component in equipment applied to problems of voltage regulation.

A number of special applications will be shown and demonstrations will be given of **Magnetic Amplifiers and Low Inertia Motors.**

Continuous Supervision of Contamination of Liquids. It is of considerable practical importance to supervise the purity of circulating liquids. By using two absorption cells and the differential output derived from a split photocell it is possible to obtain a continuous indication of the degree of contamination on a sturdy switchboard instrument. This is done by means of a magnetic amplifier connected in push-pull. Moreover, at a certain critical degree of contamination a magnetic amplifier-relay arranged in series with the indicating meter will raise the alarm. In this way, for instance, the presence of a few parts per million of a foreign component, say of oil in water, can be detected, and remedy can be provided before the objectionable presence of the contaminating agent has resulted in damage which may take days or weeks to remove.



Switching Reactors in Pulsing Circuits (see Figure)†. The switching of current pulses of considerable power and frequency is a problem which cannot be readily solved with conventional types of relays or contactors. A convenient means of performing on–off operations of bursts of energy to be supplied to a plurality of appliances or sensing members is the 'Switching Reactor'. Provided the carrier frequency of the pulses is high enough (500-2,000 c/s.) the response time of switching reactors can be kept low enough to transmit impulses of nearly rectangular shape many times per second. The control of the change between the blocking and conducting states of the switching reactor is performed by a signal winding receiving D.C. signals at a considerably lower power level. Hence a switching reactor is a means of multiplying the power handling capacity of quick acting low energy switching devices, and to obtain the performance of a high-speed high-power switching device.

Power Control by Means of Saturable Reactors†. Saturable reactors are increasingly coming into use as low loss continuous power regulators. An interesting application is the temperature regulation of resistance furnaces with the control derived either from an electronic sensing device or from thermocouples acting on magnetic amplifiers, which provide the variable input of the main saturable reactor inserted between mains and heating element.

Jet Temperature Control†. The control of jet engines and gas turbines is essentially dependent on small temperature differentials. They can be used to control magnetic amplifiers which influence the fuel supply. This can be done directly by operating a motorized throttle. Alternatively, the amplifier can act as a trimming device which biases a main compensating-type regulator. 400 c/s. amplifiers of a power amplification factor of one thousand millions are available for this purpose.

Integrating Motors, a New Component in Servo Technique†. Low Inertia Integrating Motors are now available for a considerable range of D.C. input voltages. The combination with magnetic amplifiers opens a considerable field for the appli-

cation of the integrating motor to practical problems in the field of servo applications. Complex arrangements involving a number of time constants can be studied in this way.

Relays†. The following modern types are shown :

Miniature polarized relay type 'MIN'; Midget type M.T.R. and M.T.R. sealed ; XE and E relays with and without time lag ; Heavy duty relays type H.15 ; Utility models of vertical and microwatt mercury type relays.

Scientific Glassware† on view will include the following :

Manostat ; Waterstill ; Ring potentiometers ; Adjustable and fixed type contact thermometers ; Temperature control units.

Miniature pre-set resistors† (continuously adjustable).

Low voltage **lightning arrestors** for distribution circuits.

Stand 18

LYDIATE ASH LABORATORIES,

Lydiate Ash, nr. Bromsgrove, Worcs.

Moving Film Oscilloscope Camera†. The camera exhibited represents an entirely fresh approach to the design of an oscilloscope camera, and every refinement of a worth-while nature has been incorporated to ensure certainty and convenience of operation. The instrument is robustly constructed to withstand continuous duty over a long period of time and all shafts are mounted on precision ball races and the gears lubricated by pump circulation. A 60 to 1 change of speed can be obtained by the gearbox with the camera in operation and it is therefore possible to set up on low speed and engage the high speed immediately before recording. Full electronic control of the driving motor combined with the gearbox provides film speeds from 3 in. per minute to 120 in. per second. Other important features are : the Interchangeable Magazines of 400 feet capacity, the built-in Timing Marker, the provision for photographic Data Cards and the push button operation through interlocking relays. DEMONSTRATION.

Decade Scaling Equipment†. A new and improved model of the L.A.L. Decade Scaler is shown employing a scale of 2×5. The Scaling Units are entirely self-contained with the exception of the power supplies and individually will accept any input wave shape without auxiliary apparatus. Reliable operation is achieved with 20% tolerance in all components, the maximum rate of counting being about 200,000 per second. Accessory units include Gating Units, Crystal Controlled Oscillators, Mechanical Counters and provision for resetting each decade to any numeral selected by a ten-way switch. DEMONSTRATION.

Microsecond Chronometer. The basic instrument consists of an ultra high speed scaler capable of scaling an input frequency of 2 Mc/s. Binary stages are used initially giving a scale of $2^3 \times 5^3$. To avoid the necessity of special tables for evaluating the count, an electromechanical scanning system is employed which prints the result on paper strip.

Pressure Indicating Equipment†. Capacity type pick-ups are used with frequency modulation. A small 'Remote Unit' is supplied which may be mounted

up to 10 – 15 feet from the pick-up head. The Remote Units are connected to the Display Unit with ordinary V.I.R. cable which may extend to a distance of several hundred feet. A valuable feature is that the Remote Units incorporate a reactance valve so that the effective capacity in circuit with the pick-up heads can be adjusted by a D.C. signal from the Display Unit ; in addition a test signal can be transmitted for checking the entire channel. A pressure rise of 0·5 millisecond can be handled over 150 feet distance and the apparatus can indicate a static pressure indefinitely. A portable oscilloscope is used for display purposes.

DEMONSTRATION.

Electronic High Temperature Indicator. A narrow beam of pulsed supersonic energy is transmitted across the high temperature zone and the velocity of propagation determined. Temperature of the order of 2000°C. are indicated directly on a cathode-ray tube by means of a partly 'blacked-out' circular trace. Means are provided for making corrections based on analysis of the gases present.

Stand 19

20th CENTURY ELECTRONICS,

Dunbar Works, Dunbar Street, West Norwood, London, S.E.27

An extended range of Geiger-Müller Counter Tubes is shown and also a selection of precision built Cathode-Ray Tubes.

There are demonstrations of a counter tube working at a low temperature and of single and double beam Cathode-Ray Tubes in operation.

Halogen Quenched Low Voltage Counter Tube (G.10H)†. This tube has been developed in collaboration with A.E.R.E. under a Ministry of Supply contract to meet the demand for a low voltage counter tube for portable and prospecting apparatus which are used with batteries. It has an increased life compared with normal argon–alcohol tubes.

Low Temperature G.M. Tubes (B.6E, B.12E, G.12E, G.26E, G.60E)†. Ethyl Bromide has been introduced as a quenching agent ; the advantage of this filling is that tubes will work down to – 20°C. whereas alcohol quenched tubes are not reliable at temperatures lower than + 10°C.

The threshold of an ethyl bromide quenched tube (with carbon cathode) rises approximately 1 volt per degree Centigrade rise of temperature, which again is better than with ethyl alcohol quenching.

Users contemplating ' coincidence ' working, should bear in mind that while (apart from wall absorption) the efficiency of an alcohol quenched beta counter tube is 100% the efficiency of similar ethyl bromide quenching tubes is only about 70%. However, for many purposes, this reduction of efficiency will be insignificant, and the better temperature performance will be an adequate recommendation.

A tube shown operating with an Ethyl Bromide filling demonstrates the advantages over conventional fillings at a temperature of 0°C. A standard Geiger Counter equipment is in use with power pack, scaler and probe unit.

DEMONSTRATION.

Demountable Liquid Type (D.M.6)†. This is a thin-walled beta counter tube in which a surrounding test-tube is fitted to the envelope by means of a

ground glass joint (E. J. Harris, *J. Sci. Instrum.*, 1949, **26,** 245). Beta counts can be taken directly from a 10 ml. sample of liquid poured into the test-tube. The fact that the test-tube is completely detachable has certain advantages over the well-known M.6 tube where in certain applications cleaning and other handling difficulties are involved.

Immersion Type (B.24)†. This is a thin-walled beta counter, wall thickness 30-40 mg/cm^2 in which the length of thin wall is 24 cm. It is available for use in monitoring large areas or where samples deposited on filter papers have to be wrapped round the largest area possible.

Gas Analysis (GA.26)†. This tube is designed to work with ^{14}C and is an internal Beta Counter.

Experimental Geiger-Counter Tubes. A selection of experimental tubes is shown including types which are not fully standardized.

Cathode-Ray Tubes†.

Single Beam flat-ended electrostatic tubes type S6B and S4B screen sizes 6 in. and 4 in. are shown. These Cathode-Ray Tubes have been designed to fulfil the need for precision instruments of the highest possible quality and embody a number of novel features.

Double Beam tube, type D6B. This tube incorporates two completely independent sets of work plates. The two beams are accurately aligned and are completely free from intermodulation. It is intended for the examination of two phenomena coincident in time, where a beam switching arrangement would not be practicable.

Cross Section Models of single beam and double beam tubes are shown.

Demonstration is shown of single and double beam Cathode-Ray Tubes operating at 2 kv. DEMONSTRATION.

Stand 20

A. GALLENKAMP & CO. Ltd.,

Finsbury Square, London, E.C.2

Micro-melting Point Apparatus†. This apparatus is mounted on a microscope stage and consists of an electrically heated metal block, carefully insulated, mounted on a plastic base. Very small crystals can be placed on a thin cover glass and the temperature rise controlled by a variable transformer to the required rate. Accurate melting points are determined very easily. DEMONSTRATION.

Photoelectric Colorimeter†. A self-contained mains operated instrument for comparing the absorptions of liquids. Light from a small lamp, fed from a constant voltage source, passes through a heat absorbing filter, a suitable colour filter and the sample contained in an optical cell, and finally on to a photocell connected through a resistance network to a moving-coil microammeter. Two test cells can be inserted in the instrument and either moved in the light path by means of a sliding carriage, thus speeding up the test procedure. Various accessories, including test tube adaptors and stands, are shown. DEMONSTRATION.

Small Muffle Furnace†. An electrically heated muffle furnace, size 6 in. × 3 in. × 3 in. working space. It has a simple counter-balanced door. Maximum

temperature of operation is 1000°c. Temperature is controlled by an energy regulator and indicated by a $2\frac{1}{4}$ in. instrument fitted in the skirt. The furnace is completely self-contained and is intended for the laboratory or workshop, where a small and economical unit of reasonable accuracy is required. DEMONSTRATION.

Viscometer Bath†. An accurate thermostatic bath intended for use up to 100°c. with a differential of better than $\pm 0{\cdot}01$°c. Efficient and quiet stirring is achieved by a shaded pole motor and flexible stirring shaft. The thermoregulator is a sensitive liquid expansion type operating in conjunction with an electronic relay and a carefully balanced heat input. Alternate temperature control is derived from a new type of contact thermometer. DEMONSTRATION.

Low Voltage Furnace†. A tube furnace for temperatures up to 1250°c., heated by a heavy spiral element running at less than 20 volts. This is supplied from a multi-tapped, built-in transformer. DEMONSTRATION.

Silicon Carbide Element Furnace†. This is also a tube furnace, but for operation up to 1400°c. It is heated by two elements connected in parallel and the comparatively low voltage, high current required is derived from a multi-tapped transformer. DEMONSTRATION.

Stand 21

GRIFFIN & TATLOCK Ltd.,
Kemble Street, London, W.C.2

Reflecting Magnetometer, Sucksmith† (Figure 1). *J. Sci. Instrum.*, 1945, **22**, 129.

One of the chief shortcomings in the use of mirror magnetometers is the long period of oscillation which, together with the low damping, makes any set of readings a tedious procedure. The use of low coercivity carbon steel magnets in the moving system results in a small ratio of magnetic moment to moment of inertia, so that the period of oscillation is generally greater than five seconds and, even with adequate damping, the time for the suspended system to reach equilibrium may be as much as thirty seconds.

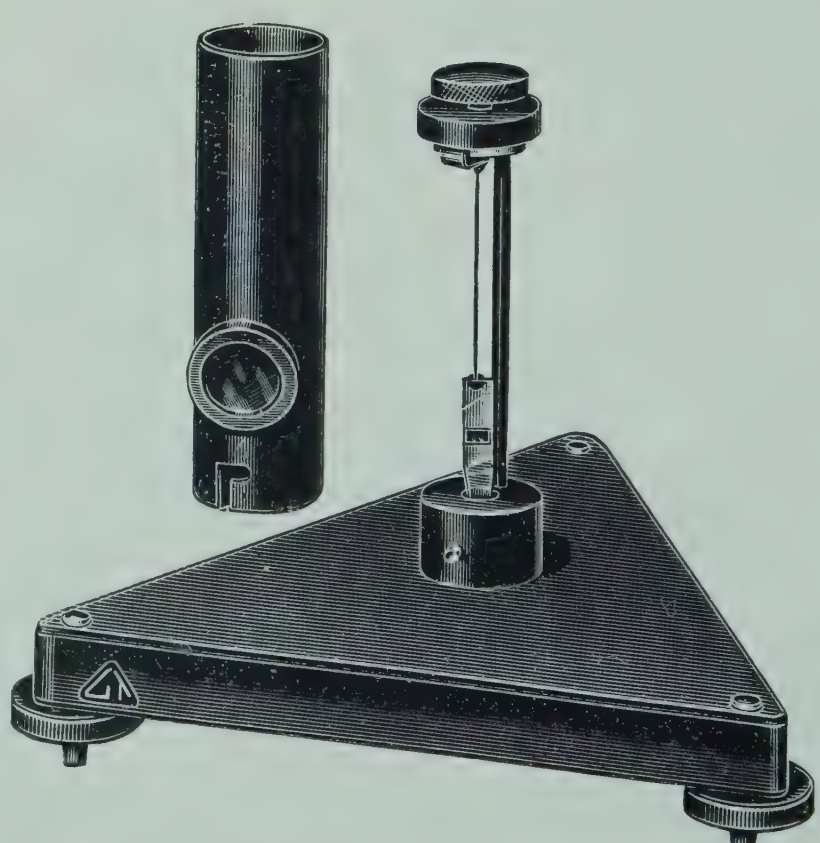


Figure 1. Reflecting Magnetometer, Sucksmith

In the Sucksmith magnetometer the use of the newer anisotropic magnet materials of coercive force 500-600 oe. provides a means of reducing considerably the time of oscillation, while currents induced by the motion of the magnet greatly improve the damping. The system comprises an unspun silk suspension to which is attached a mica vane having on one of its faces a mirror, and attached at the lower end of the vane, on opposite faces, two square-sectioned anisotropic magnets 5 mm. long × 1 mm. wide. This part of the vane oscillates inside a conical aperture bored in a copper block. The clearance between the magnets

and the block can be adjusted by raising or lowering the suspension, and hence the degree of electromagnetic damping can be controlled.

Heavy Element Tube Furnace † (Figure 2). The salient feature of these new furnaces is the use of an inexpensive heavy gauge alloy element, which is self-supporting and which can be withdrawn and replaced in a few moments.

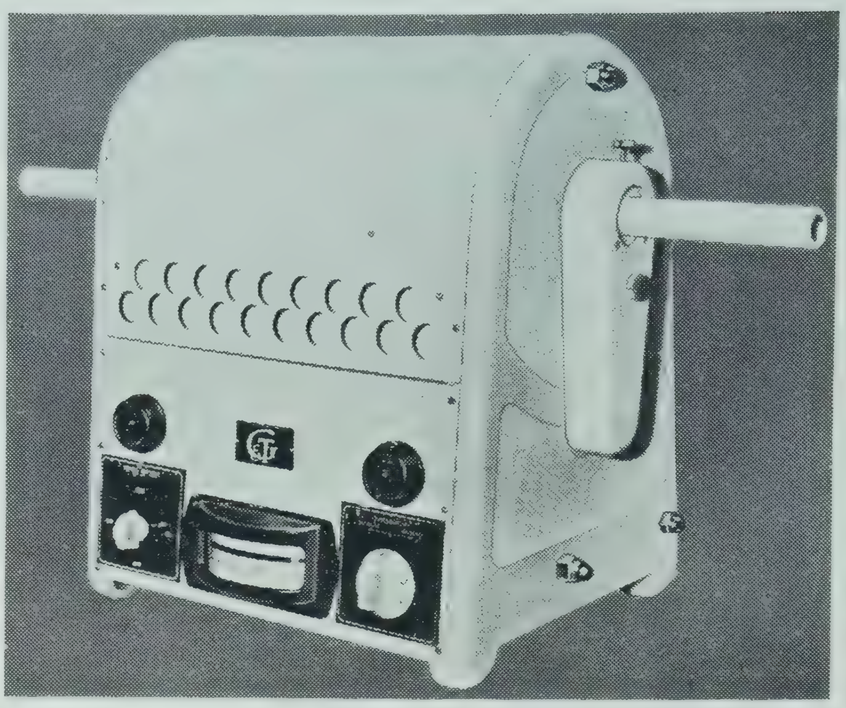


Figure 2. Heavy Element Tube Furnace

This element, designed to take a combustion tube $1\frac{1}{8}$ in. outside diameter and usually $\frac{7}{8}$ in. bore, which it heats over a length of 10 in., is fed at 18 volts, 50 amp., from a transformer built into the base of the casing, which is adequately ventilated so that all controls are kept cool. The furnace can be run continuously at temperatures up to 1150°c. which temperature is attained twenty minutes after switching on. For short periods it can be run at 1200°c. With the built-in Simmerstat, a temperature constancy of $\pm$ 5°c. can be achieved. A pyrometer with 4 in. scale, reading to 1400°c. is included. A double tube furnace is also available.

Surface Area of Powders Apparatus, Rigden† (Figure 3). *J. Soc. Chem. Ind.*, 1943, **62**, 1.

Of the methods available for determining the surface area of powders, the permeability method is perhaps the most attractive in providing a rapid direct determination not requiring a knowledge of particle shape factors. The apparatus exhibited has been evolved from a modification made by Rigden of the Lea–Nurse method. This method depends upon a relation between the rate at which air will flow, under a given pressure gradient, through a bed of compressed powder, and the solid density, fractional voids and surface area of the particles of that bed.

The apparatus consists of a permeability cell, the ends of which are connected to the two limbs of a precision-bore glass U-tube containing a liquid of low viscosity and negligible vapour pressure. The liquid in the U-tube is displaced and, in returning to the

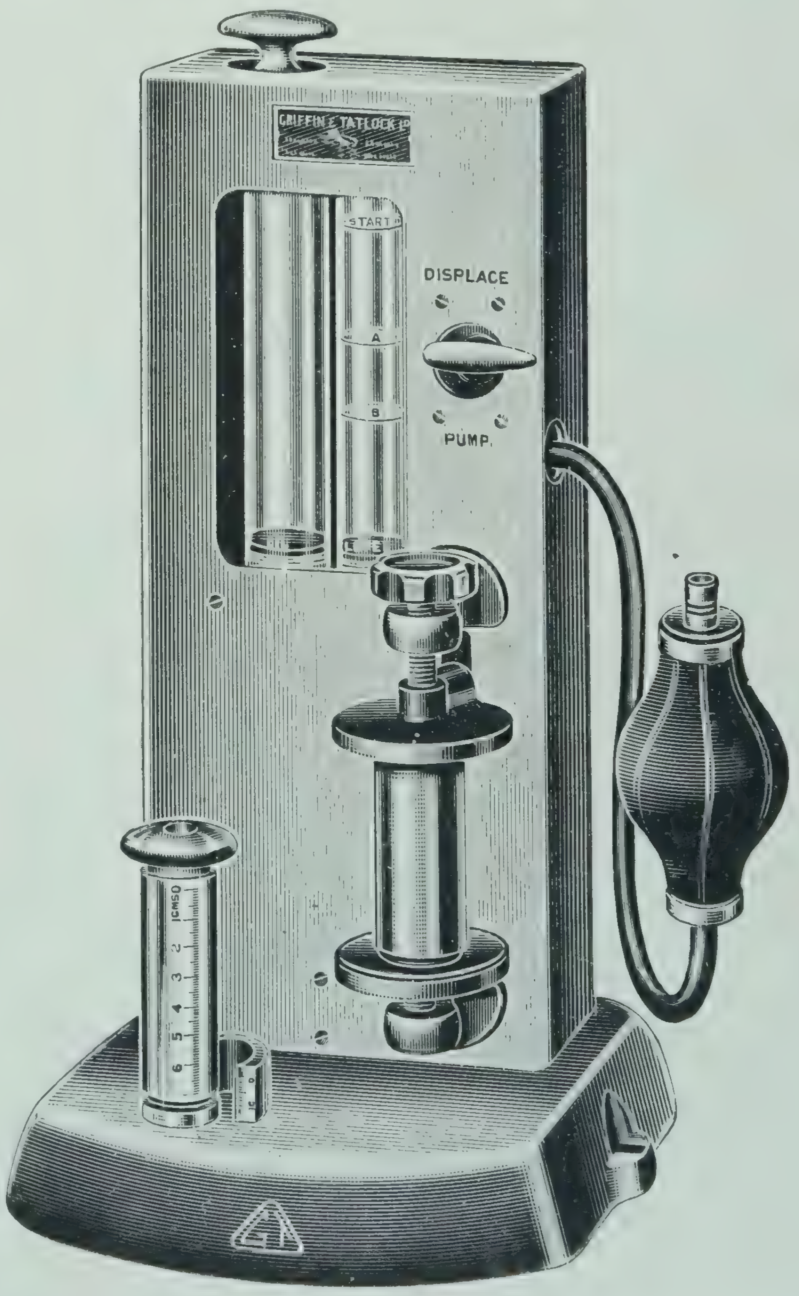


Figure 3. Surface Area of Powders

equilibrium position, forces air through the bed. Measurement of the rate of movement of the liquid level in the U-tube simultaneously provides the rate of flow and the pressure across the bed at any instant.

Another novel modification is the manner of forming the compressed bed of powder. This is built up in layers until the required depth is reached ensuring uniformity of packing density, both axial and radial. The depth is read off directly on a special vernier scale.

The method is applicable to powders ranging in specific surface from 500 to 50,000 $cm^2/gm.$, i.e., 40 μ down to 0·4 μ assuming powders of specific gravity 3.

Coating Thickness Tester, Magnetic, A.R.D†. (British Patent No. 575150). *J. Electrodepositors' Tech. Soc.*, 1945, **20**, 139.

The measurement of the thickness of electrodeposited platings, paint films and other non-magnetic coatings on ferromagnetic basis metals, has become of increasing importance in recent years. Instruments for this purpose are available, but are often complicated and expensive.

The A.R.D. Magnetic Coating Thickness Tester is a simple, robust and compact instrument in which the force required to detach one pole of a permanent magnet from the coated steel is measured, using the 'steel-yard' principle. The thickness of the coating is then derived from calibration curves prepared with the aid of standard specimens.

Briefly, a pivoted beam mounted on a Keramot base carries a hemispherically ended cylindrical magnet on the end of one arm, and a weight free to move in a helical track on the other. With the weight near the fulcrum, the magnet adheres to the coated component which is placed beneath the base of the instrument, but on moving the weight outwards along the beam, a position can be found where the magnet detaches and the arm tilts. A graduated scale is provided for use in measuring the displacement of the weight.

A calibration curve is supplied covering the range of each instrument, and coating thickness can be read off for any specific scale reading. By using interchangeable weights of different masses, the range of the instrument can be adjusted. A set of standard specimens of electrodeposited chromium platings of known thickness on mild steel is included, mounted in a manner to enable the instrument to be checked at any time against the calibration curve supplied. The mount for the set of specimens is designed to eliminate external magnetic interference.

A Thermostatically Controlled Glass Electrode, Le Brocq† (Figure 4). *Chem. & Ind.* 1943, 350.

When accurate pH measurements are being made, attention must be paid to the temperature of the solution under test. Although it is possible to allow for the effects of temperature changes on the standard reference electrode and the glass electrode, no universal compensation can be made for the effect of temperature change on the pH of the unknown solution itself, as different solutions have different temperature coefficients. When accurate comparisons are to be made and close reproducibility is required, it is therefore desirable that the pH measurements should be made at constant temperature.

The apparatus shown consists of a glass electrode-saturated calomel electrode assembly immersed in a water thermostat. The thermostat is heated by a 20-watt tubular lamp, and the temperature is controlled by a contact thermometer

working a Sunvic relay housed in the base of the apparatus. To avoid electrical interference or mechanical vibration of the electrode system, the water is stirred by an air-lift water circulator, and shielded electrical wiring is used throughout. A water-cooling coil is provided should the thermostat be required to work at less than room temperature. A control to 0·1°c. is readily obtained.

The cell assembly can be rapidly filled and emptied without splashing. Contact between the calomel half-cell and the unknown solution is made through a ground-glass joint wet with potassium chloride. Contamination of the unknown solution by potassium chloride is negligible, while the electrical contact is excellent.

The glass parts of the apparatus, including the calomel half-cell, may be readily detached for cleaning. The parts are standard and interchangeable.

The glass electrode may be replaced by other electrode systems such as hydrogen or antimony electrodes. The Rideal hydrogen electrode is particularly convenient.

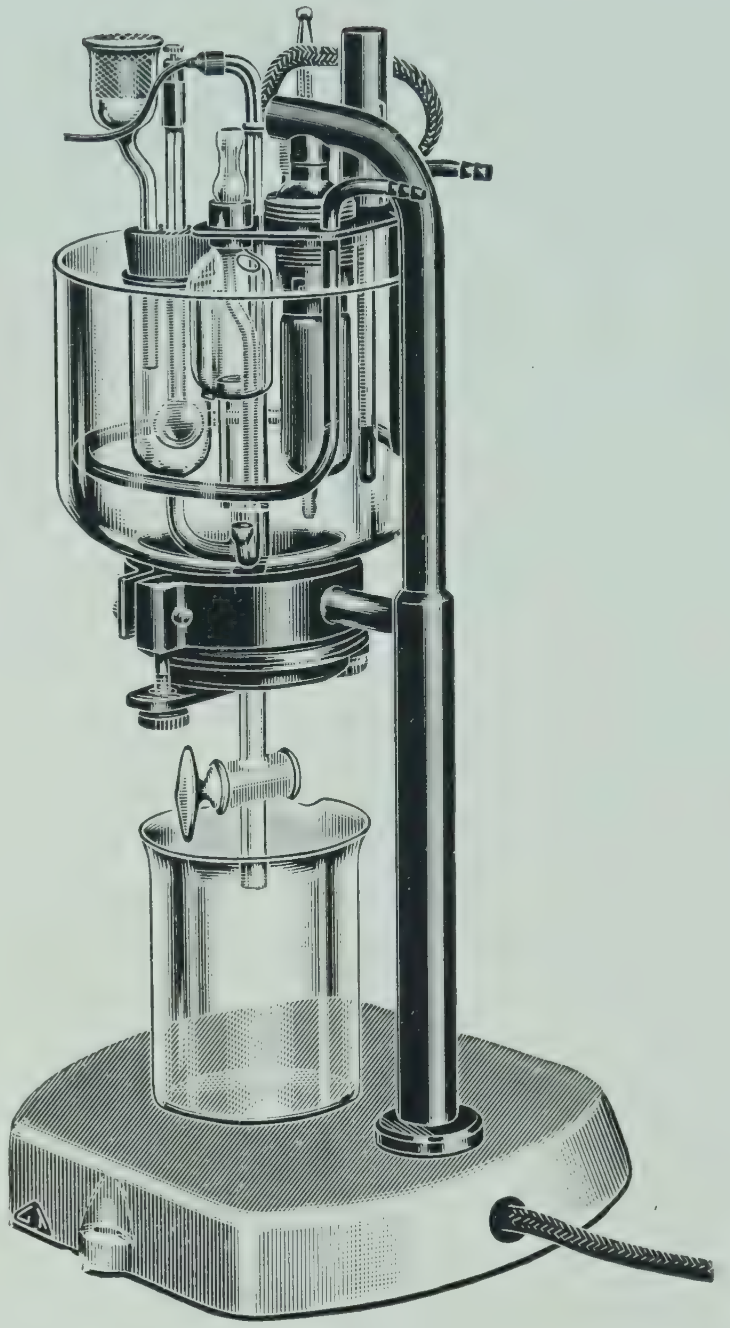


Figure 4. A Thermostatically Controlled Glass Electrode

With this apparatus and a suitable valve potentiometer, pH measurements with a reproducibility of 0·02, or, with care, 0·01 pH unit, can be obtained.

Brownian Movement Apparatus† (Figure 5). With this device, the demonstration of Brownian movement in smoke particles is made very simple. A rectangular metal chamber is fitted on one vertical face with a lens through which light from a powerful source is made to converge near a plane glass disc placed in the upper horizontal surface. Compression and release of the rubber

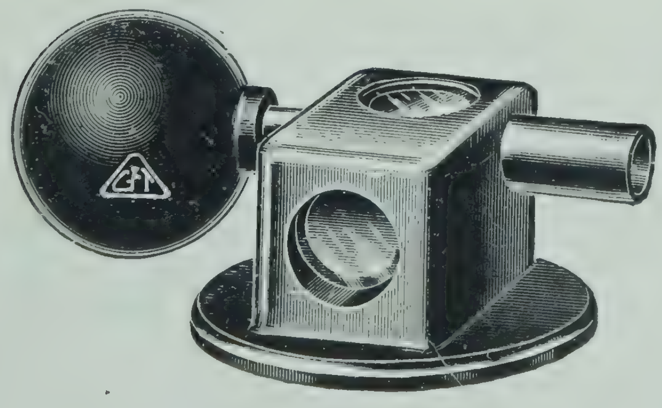


Figure 5. Brownian Movement

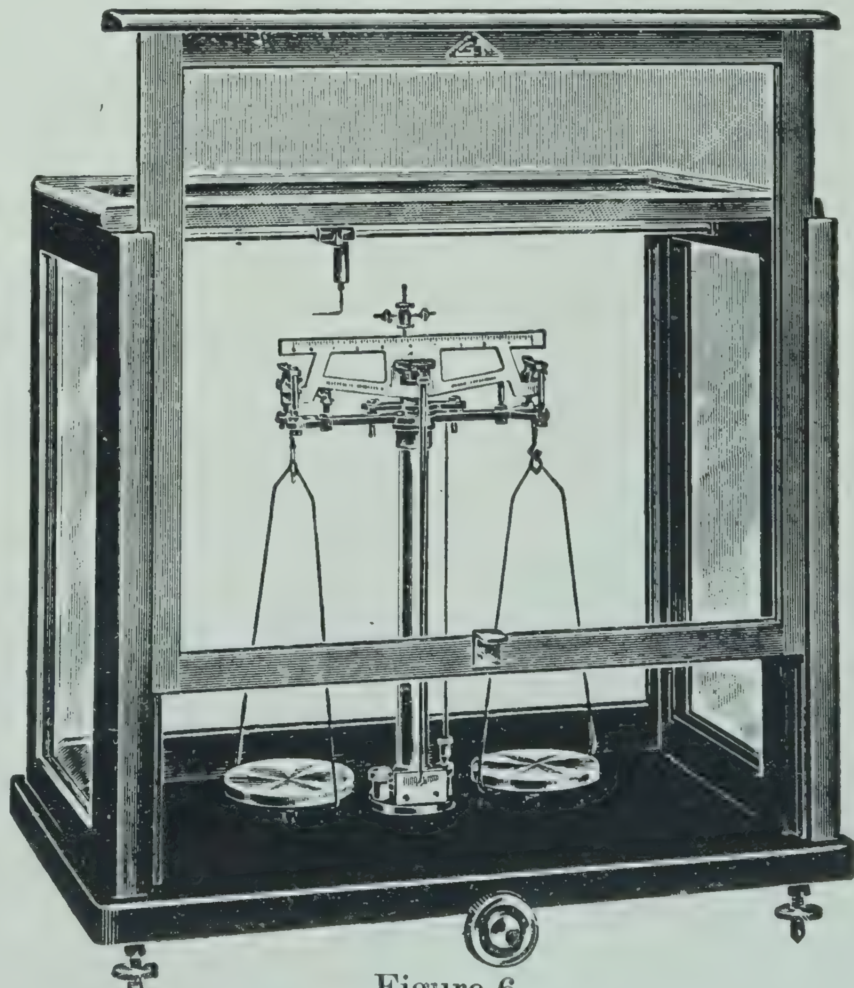


Figure 6. Microid Analytical Balance

field in gauss is numerically equal to the current in amperes. The balance point is determined by a jewel-mounted compass. Hence a simple method is available for determining rapidly the strength of the earth's field at different points in the laboratory, and determination of the magnetic moment of a magnet. By the provision of an extra single coil fitted with terminals, the variation of the field along the axis of a coil can also be investigated.

Conductivity Apparatus, Lees † (Figure 11). This apparatus is a simplification of the classic Lees disc. Three copper discs, each drilled to take a thermometer, are arranged in a hard asbestos-cement framework. Between two of the discs is placed an electric heating element operated from a 6-volt accumulator, and between the other two is placed a disc of the badly conducting substance under test. The whole series of discs is rigidly clamped together. Electrical connections are made to two front terminals. The experimental procedure is to pass current through the heating element until thermal equilibrium is reached. In this state, the amount of heat passing through the disc under test is equal to that required to maintain the end metal disc at the steady temperature. The calculations for the determination of conductivity follow closely those in the well-known Lees and Chorlton apparatus.

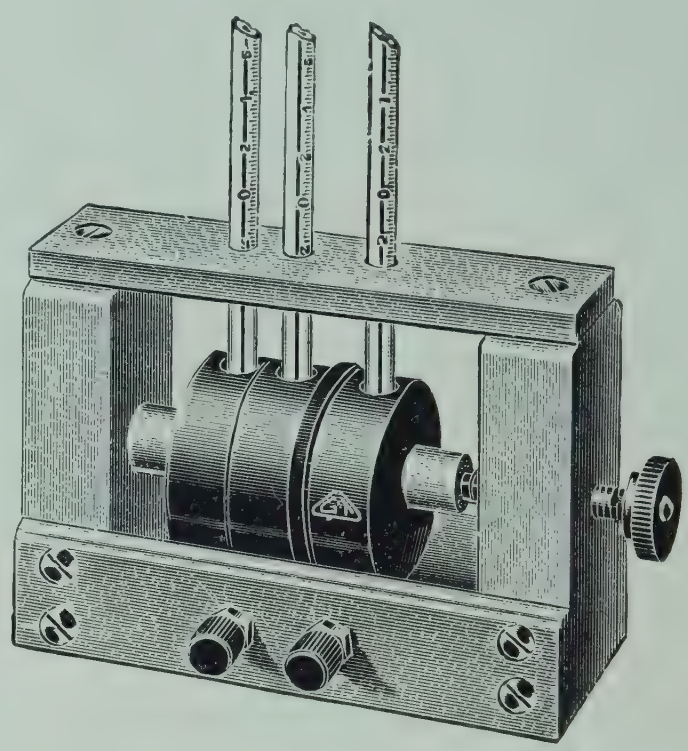


Figure 11. Conductivity Apparatus, Lees

Photoelectric Sedimentometer, Heywood (British Patent Specification 552,398). The industrial importance of particle size distribution and the surface area of powders in the sub-sieve range, has grown considerably in recent years. Of the instruments already in common use, some have definite operational disadvantages, others give the specific surface only, whilst those which also give the particle size distribution, can be used only for dry powders.

This photoelectric sedimentometer enables complete size distribution curves to be plotted with accuracy, determinations of specific surface to be made, and has the added advantage that it can be used as a photoelectric colorimeter.

Light from a battery-operated lamp, is focused by a lens system upon a glass cell containing a liquid suspension of the powder under test. The ratio of the light intensity passing through to that which passes through a standard reference cell containing the liquid only, is measured by means of a suitably disposed photoelectric cell upon which the emergent light beam is reflected by two surface-silvered mirrors. A heat filter, an adjustable shutter to compensate for light intensity variations due to voltage fluctuations, and a screen to prevent undue exposure of the photoelectric cell to the light beam, are included in the optical system, which is rigidly mounted as a complete unit on a pivoted movable carrier. Since it is essential that the suspension in the test cell is not disturbed, the test and standard cells are accommodated in stationary positions side by side in the case of the instrument, and the whole optical system rotated through a small arc, so

that the light beam is traversible from one cell to the other. The photoelectric element is connected to a microammeter so that relative light intensity is measured in terms of readings on the microammeter scale.

As the heavier particles settle, readings at intervals can be taken and a particle size distribution curve plotted. Particle size and hence specific surface can be calculated from the Stokes' equation for settlement rate.

Similarly by plotting microammeter readings against a series of colour standards in the reference cell, the instrument can be used as a photoelectric colorimeter.

The apparatus is accurate, reliable, entirely self-contained, readily portable and simple to operate, only four controls being embodied, namely, the optical system rotary mechanism, the shutter adjustment, the insertion of the screen and the lamp switch. The whole optical system unit can be easily removed for any optical adjustment.

Stand 22

SOUTHERN INSTRUMENTS Ltd.

Fernhill, Hawley, Camberley, Surrey

The exhibits described below are instruments for the measurement of electrical transients and of rapidly varying physical quantities such as pressure, force, strain, vibration, acceleration and displacement. They include a variety of transducers to convert the quantity to be measured into electrical quantities that can be amplified, and examples are also shown of specialized amplifiers and cathode-ray oscillographs with their recording camera. The variable capacity and inductance types of pick-ups operate with the Southern frequency-modulated system which uses a 2 Mc/s. carrier. This has the great advantage of being able to record down to zero frequency so that static calibration can be carried out and both very slow and very rapid variations can be recorded.

Condenser Pressure Pick-Up (Type G231)†. This is primarily for measuring arterial blood pressure. It is made of Invar Steel and incorporates a three-way tap.

Condenser Pressure Pick-Up (Type G233)†. This is an improved type made of Invar Steel and intended for general purpose work under fluctuating temperature conditions, and covers any range up to 10,000 lb/in^2.

DEMONSTRATION.

Resistance Pressure Pick-Ups (Type G207)†. These are an adaptation of the resistance strain gauge technique, the expansion of the tube under pressure being measured by the increase in resistance. Three types are exhibited, one of which can be used up to 35 ton/in^2.

Resistance Pressure Pick-Up (Type G237)†. This is intended for measurements from 1,000 up to 10,000 lb/in^2 or more. It has a temperature compensating winding and it is arranged for air cooling.

Accelerometer (Type G226)†. This works on the variable capacity principle, a mass supported on spiders being held against a diaphragm forming part of the condenser. Variations in acceleration alter the capacity. The particular advantage of this type of accelerometer is that the moving system has a very high natural

period because the condenser system is extremely sensitive and the moving system can be made very stiff. The operating frequency range is therefore very wide. A novel form of oil damping is used. Accelerometers of this type are available for ranges from 1*g* to 200*g* or more.

Vibration Pick-Up (Type G209)†. This is a seismic pick-up using a variable inductance principle with a 2 Mc/s. carrier. The amplitude range is 0·015 in. and the vibration frequency range of the type shown is from 15 c/s. upwards.

Vibration Pick-Up (Type G211)†. This is a proximity pick-up also using a variable inductance principle with 2 Mc/s. carrier. The instrument is mounted on a stationary support with the inductance close to the surface whose vibration is to be measured. The surface must be metallic or faced with a thin disc preferably of copper. A dial micrometer is incorporated for calibrating purposes. The range is up to 0·025 inch, and 0·0001 inch can be easily measured.

DEMONSTRATION.

Photo-Cell Sweep Unit (Type M738)†. This is for use with a cathode-ray oscillograph engine indicator. The unit, which is coupled to the engine shaft, contains a rotary shutter that varies the illumination on a photo-cell. The cell output is amplified and produces a time-base sweep proportional to crank angle independently of engine speed. A phasing control is provided. A magnetic pick-up and toothed disc are also incorporated to provide degree marking on the indicator diagram. DEMONSTRATION.

Direct-Coupled Amplifier (Type MR235)†. This is a very stable drift-corrected D.C. amplifier intended for strain-gauge recording and the measurement of small potentials. It contains a circuit operated by relays running at 50 c/s. that automatically compensates for any drift of zero. The stability is of the order of 0·1 millivolt over a period of many hours and within a few seconds of switching on. The frequency response is flat from 0 to 50 kc/s. It is primarily intended as a pre-amplifier to be followed by a driver amplifier for oscillograph work, the overall gain being sufficient to give full screen deflection for 2 millivolts.

DEMONSTRATION.

Universal Strain-Gauge Bridge (Type MR295)†. This is intended for use with the MR235 drift-corrected D.C. amplifier. It provides facilities for using either single gauges, matched pairs or complete bridges. DEMONSTRATION.

Single-Shot Camera (Type M726)†. This is the simplest possible camera using 35 mm. film or paper. It includes an F = 2 inch f/4·5 lens and a hood to facilitate fixing to the oscillograph. A film holder, which is detachable, accommodates up to 5 feet. A lamp adapter enables it to be used as an enlarger.

DEMONSTRATION.

Transient Recorder (Type TR10)†. This uses a 10 kv. tube and a three-sphere gap for initiating the beam and time-sweep. A delay cable, the necessary timing wave oscillator, and a simple 35 mm. single-shot camera with an f/1·0 lens are provided. This oscillograph is intended for recording transients of one microsecond duration. DEMONSTRATION.

Engine Indicator (Type ME109)†. This is a single-channel oscillograph specially designed for engine indicating with variable capacity pick-ups. It

includes an F.M. amplifier system and switching for several pick-ups and for crank-angle degree marking. DEMONSTRATION.

Oscillograph (Type ME15)†. This is a complete single-channel trolley-mounted oscillograph recorder with pre-amplifiers and a built in recording camera for continuous-feed or drum records. F.M. or D.C. pre-amplifiers can be incorporated for measurements with capacity pick-ups or strain-gauges.

DEMONSTRATION.

Stand 23

SUNVIC CONTROLS LIMITED,

10, Essex Street, Strand, London, W.C.2

D.C. Amplifier† (Figure 1).

Operation: The D.C. input is connected to a vibrator which changes the D.C. voltage into a square wave. After suitable A.C. amplification, the amplified signal is rectified and connected to either a D.C. milliammeter indicator or to a recorder. A high degree of negative feedback is applied giving high stability and linearity. The degree of feedback is such that the overall gain is determined mainly by the Feedback Resistance. The Resistance can therefore be used as a reliable gain adjustment.

Figure 1.

Input Voltage Ranges. 0-100 mv., 0-1 mv., 0-100 mv. These values can be varied if desired.

Accuracy. 1% on 100 v. range. 0·1% on 1 m.v range.

Speed. Maximum 1/10 second full scale.

Maximum Output. ± 5 ma. into a maximum load of 4,000 ohms.

Resistance Thermometer Controller†. A circuit containing a gas-filled tetrode valve is arranged to cycle so that current is taken by the valve for about 15 seconds and then ceases for the next 15 seconds. The cycle is made to repeat itself. The control circuit of a vacuum switch is included in the anode of the gas-filled tetrode, the contacts of the vacuum switch being connected in the furnace circuit.

The out-of-balance voltage of a resistance bridge containing a resistance thermometer (which is in the furnace) is fed to an A.C. amplifier, the output of which is connected in the grid circuit of the gas-filled tetrode. The amplifier output is proportional to bridge input signal, and is arranged to be in quadrature with the anode voltage of the gas-filled tetrode. The amplified signal modifies the natural cycle times of the circuit mentioned above and the percentage 'ON' time is arranged to be approximately proportional to the error or bridge signal. Proportional temperature control is thereby applied to the furnace.

Electronic Relay Type EA. 3† (Figure 2). This relay is very compact, having overall dimensions of approximately $6\frac{1}{8}$ in. × $4\frac{1}{4}$ in. × $2\frac{3}{4}$ in. It will control a maximum load of 2 kw. at 230 v. and is suitable for use where instrument contact current of voltage must be a minimum.

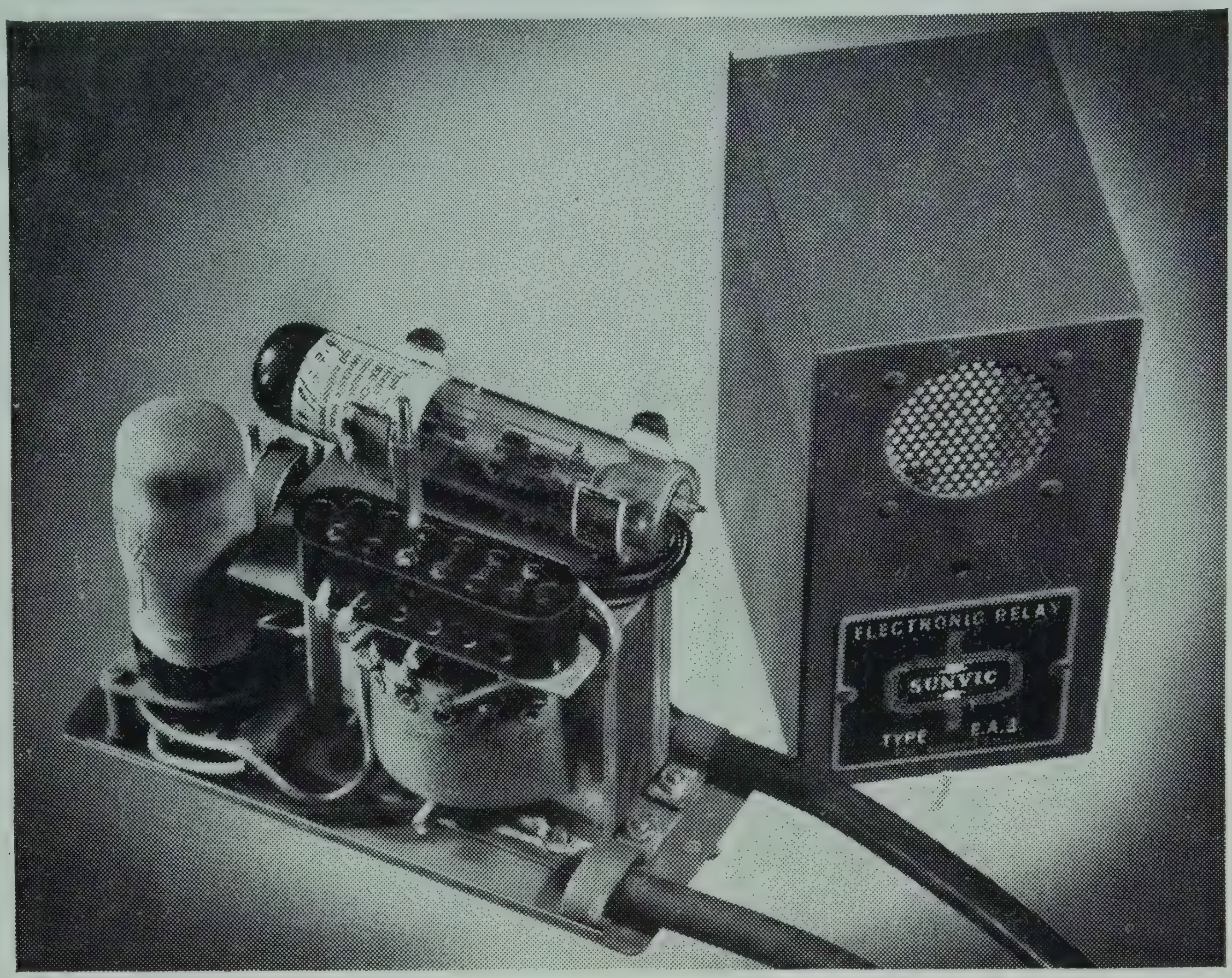


Figure 2.

Bimetal Thermostats†. A number of accurate thermostats will be exhibited incorporating the following features (i) proportional control, (ii) continuous adjustment from 0-300°c. with coarse and fine control, (iii) right-angle drive, (iv) flexible drive with negligible backlash.

H.T. Thermostat. This is a differential stem type thermostat fitted with proportional control and suitable for temperatures up to 500°c.

Cold Junction Thermostat†. This unit has been designed to take thermocouple cold junctions and maintain them to an accuracy better than ± 0·1°c. It can be used to replace existing thermos flasks with the advantage that it is fully automatic and requires no attention. The diameter of the control chamber is $\frac{3}{4}$ inch.

Energy Regulators†. Type ERL is similar in dimension to ERH but is fitted with a special cam, to allow linear adjustment of input.

Type TYW is for wall mounting and incorporates standard three-pin socket outlet. It can be used to control diversity of apparatus in which no temperature control is fitted.

Fatigue Machine Control Unit. A Fatigue Machine built to N.P.L. design will be demonstrated. The specimen is fitted with a pick-up head which translates the mechanical movement into an A.C. signal. This signal is amplified and used to operate a drive unit capable of maintaining the specimen at its natural fre-

quency. Adjustment can be made to the amplitude and by the introduction of feedback, constant amplitude can be maintained.

Magnetic Vacuum Switches. Models will be exhibited in which the contact assembly is enclosed in a hard vacuum with the operating coil external to the tube. The design is such that the switch will operate independent of its mounting position and is free from vibration. These units are capable of switching loads of 15 amp. at voltages up to 1,000 V. A.C. or D.C.

Stand 24

W. & J. GEORGE & BECKER Ltd.

17-29 Hatton Wall, London E.C.1

157 Great Charles Street, Birmingham 3

Nivoc Semi-Micro Balance (Aperiodic) ND126† (Figure 1), capacity 50 gm., sensitivity 0·01 mg.

The beam of the Nivoc Semi-Micro Aperiodic Balance is extremely light and strong and has a special arrangement to counterbalance the weight of the aluminium pointer and photographic scale.

The pans are 2 in. in diameter and slightly concave. The pan frames, which have a usable height of 5 in. and a width of 3·25 in., are suspended from the top hook of the stirrups and have a cross bar which provides support for weighing tubes. The air damping cups are suspended from the lower hook of the stirrups. The 'degree of damping' with no load is 22 seconds, with full load 37 seconds.

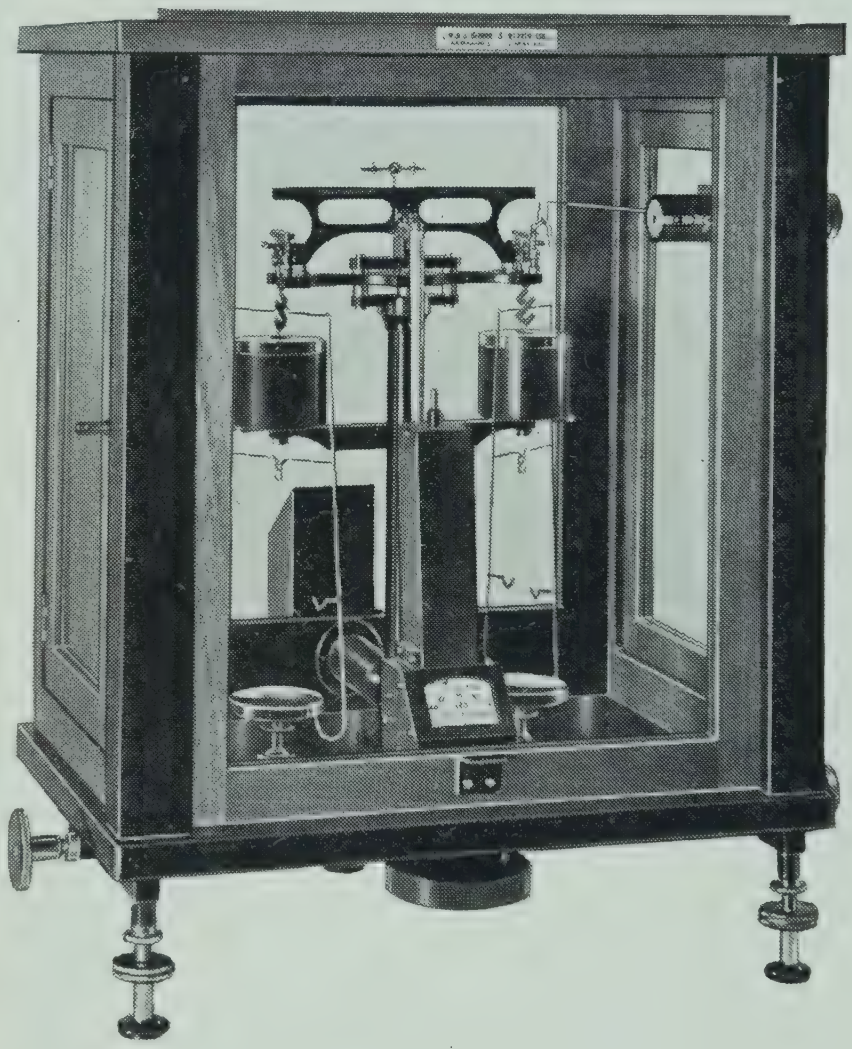


Figure 1.

The pan supports incorporate a delicately spring-loaded ball which bears against the underside of the pans in the rest position and prevents oscillation of the pans though they are still free to take up their equilibrium position.

A knob outside the case operates the weight-change mechanism and when rotated through four positions corresponds to the addition of 0, 30, 60 and 90 mg.

The magnified image of the graticule attached to the pointer is thrown on to a screen conveniently situated at pan level on the base of the balance. The lamp-house on the outside of the case is open at the top for maximum ventilation. The condenser lens, also outside the case, is freely ventilated and is fitted with a heat filter. The projection lens is focused by finger tip control of a stud sliding in a helical slot in the supporting sleeve.

The graticule is divided into 300 divisions, numbered from 0 to 300, one division (about 1/10 in. on the magnified image of the screen) being equal to 0·1 mg.

After weighing, a micrometer knob which controls the hair line is made to cut the last division on the left of the main scale and the auxiliary scale then shows the number of hundredths of a milligram to be added to the reading on the main scale. Zero adjustment is effected by means of a knob on the right-hand side of the case below base level. (Patented).

Nivoc Aperiodic Balance A6500† (Figure 2). Capacity 200 gm., sensitivity 0·1 mg.

The Nivoc Aperiodic Balance is extremely simple in operation so that it can be used and accurate readings taken by operators unaccustomed to handling analytical balances. The ring weights of 300 mg. and 600 mg. are operated by the rotation of a knurled knob enabling readings up to 1·2 grammes to be made without opening the case. (Patented.)

Other details are as follows :

Beam. 5·5 in. hard rolled brass.

Knife-edges and planes. Selected Agate.

Pans and Frames. Chromium-plated brass pans. Pans concave, 3·25 in. diameter. Maximum width of frame 4 in.

Illumination. 12 volt 24 watt lamp, fully adjustable.

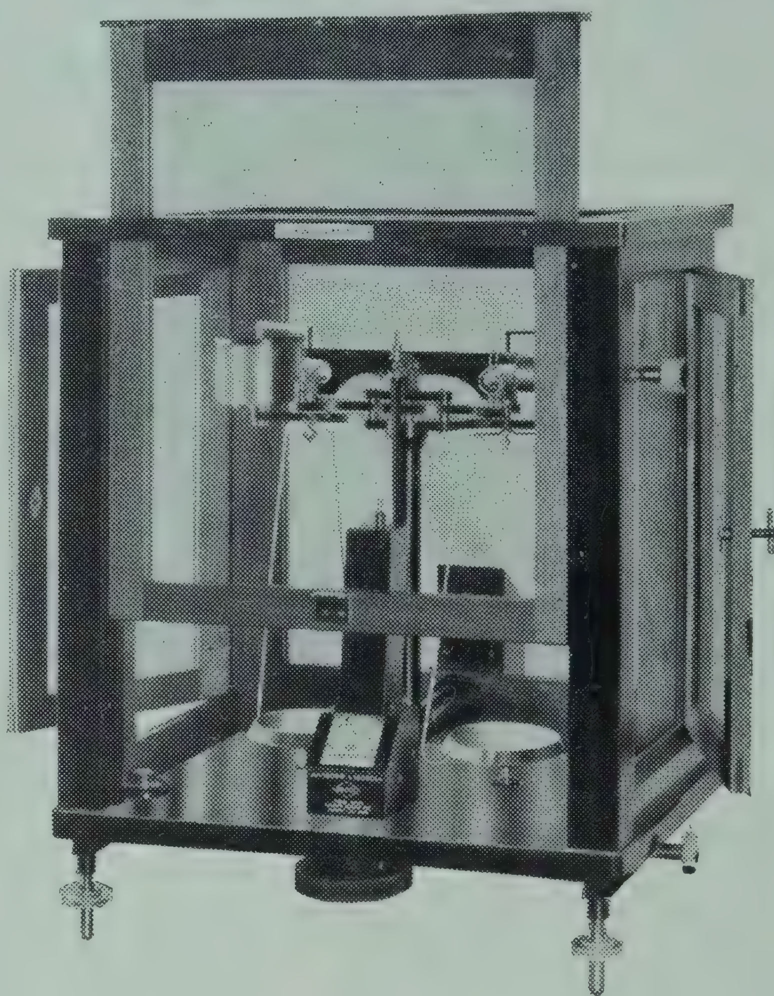


Figure 2.

Nivoc Analytical Balance with Magnetic Damping 537-5† (Figure 3). capacity 250 gm., sensitivity 0·1 mg.

The basis of the present Nivoc Analytical Balance with Magnetic Damping is a newly designed light alloy beam with fall-away arrestment mechanism. Suspended from the one pan hanger is a high conductivity cylinder moving in the relatively wide gap between a small high performance cylindrical magnet and the shielding cylinder which surrounds it. Relative movement of the damping cylinder and magnet system produces eddy currents which quickly bring the balance arms to rest. Without the device the balance arms oscillate for more than ten minutes when displaced through 5 divisions; with

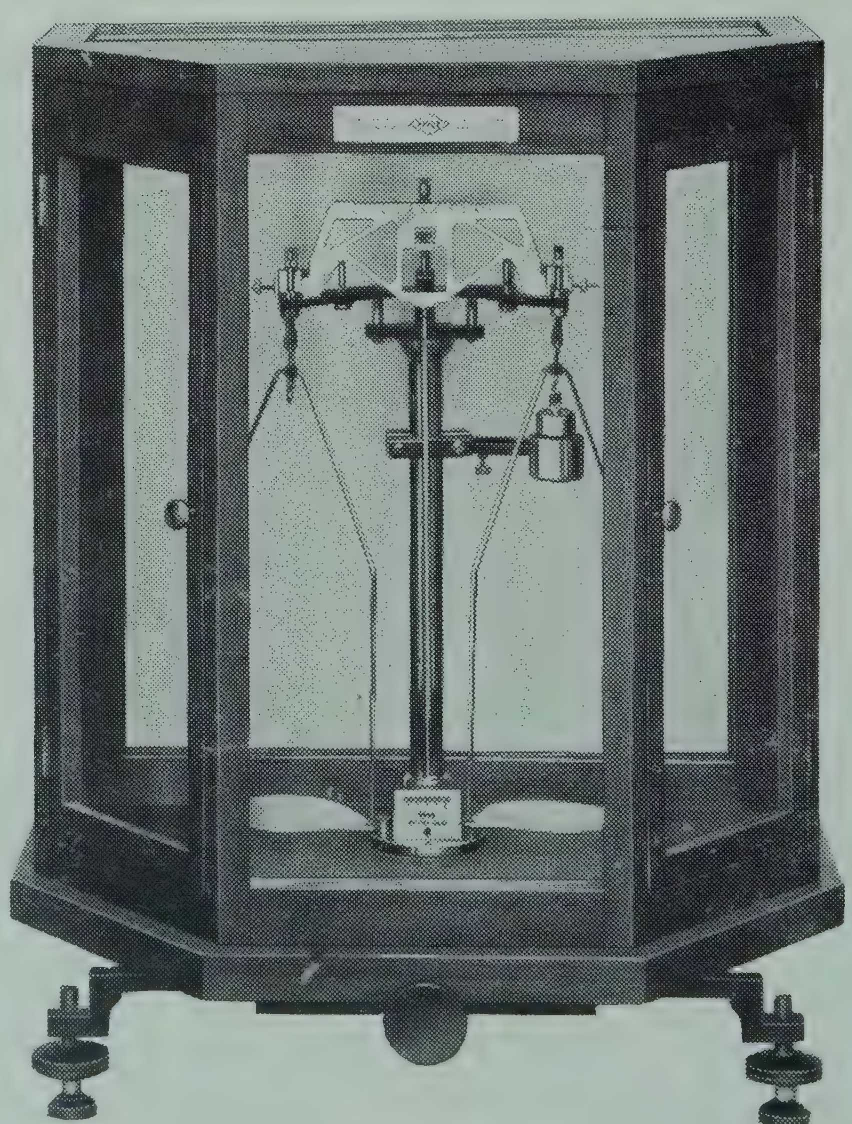


Figure 3.

the device in action movement is completed in about 12 seconds. The design of the magnet system is such that the stray field is negligible and does not affect the apparent weight of objects weighed on the balance even if they are ferromagnetic.

The Balance is contained in a well designed case with side opening doors which give free and direct access to the balance pans.

Nivoc Anti-Vibration Table ND122† (Figure 4). This Table has been designed to allow delicate balances and instruments to be used in positions which would be otherwise impracticable. Unlike other tables for the same purpose the Nivoc Anti-Vibration Table is extremely compact, raising the level of the instrument by $1\frac{1}{4}$ in. only. It may be placed directly on a normal height bench, which does not have to be bored out or modified in any way.

Figure 4. Nivoc Anti-Vibration Table.

The design of the table is fully geometric, both in that it is completely stable on an uneven surface and also in the method of positive location of the balance upon the table.

Wright Sonometer†. This instrument, which was designed by P. Wright, Ph.D., F.Inst.P., combines in one apparatus a resonance tube of the Kundt type and a tension spring type of Sonometer. The two are mounted on a common baseboard so that vibrations produced by the longitudinal oscillations of the sounding rod are transmitted to the sonometer wire, which will vibrate in resonance under suitable conditions. (Patented).

Nivoc Mirror and Pointer Galvanometer 16964M† (Figure 5). This is a robust yet sensitive instrument of the taut suspension type, fitted with a self-locking clamp, operating when the galvanometer is lifted from the bench. In the locked position it may be safely subjected to considerable mechanical shock. The case is only $3\frac{1}{4}$ in. square and 4 in. high, but a scale 7 cm. long has been successfully incorporated. A mirror is attached to the vertical suspension, visible through a window in the back of the case.

The deflection at one metre is of the order of 40 mm. per microamp and the period 1·2 seconds. The pointer deflection is approximately 0·5 divisions per

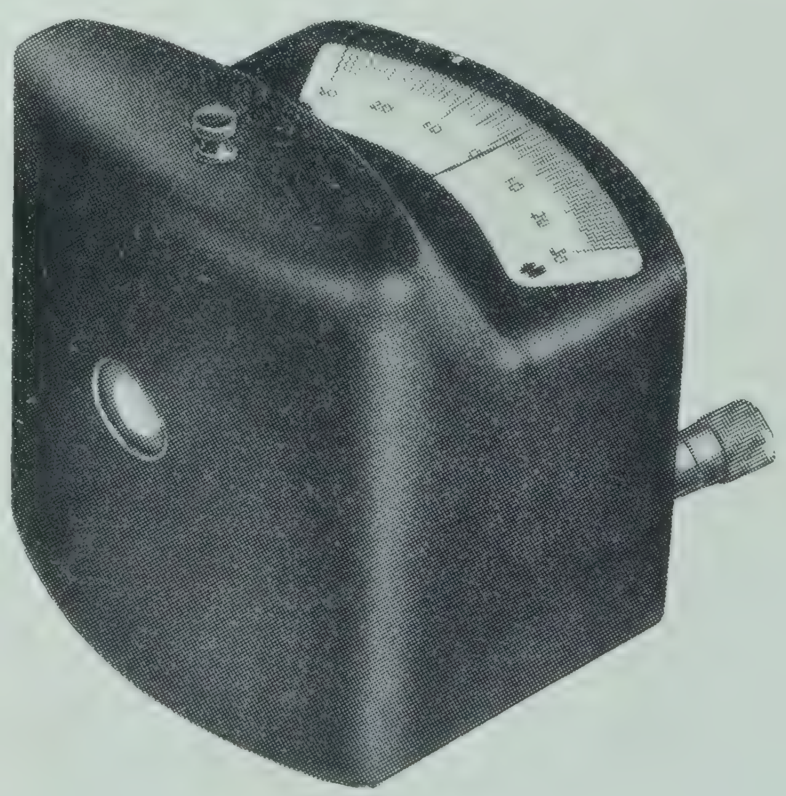


Figure 5.
The Nivoc Mirror and Pointer Galvanometer.

microamp and the standard resistance 25 ohms.

The case is die-cast from a light but strong alloy.

Although the instrument is supplied only in the aperiodic form, it is completely capable of making ballistic measurements and is superior for that purpose to a short period ballistic galvanometer.

Nivoc Optical Bench ND130 (with full range of accessories)† (Figure 6). This Optical Bench has been largely redesigned and a new type of lens holder with a self-centring action incorporated. These holders will accommodate and centre any circular lens from 1 cm. to 7·5 cm. in diameter. There are, in addition, special holders to take any of a number of circular screens and diaphragms, all of which are pre-centred. Because of these self-centring holders no provision is necessary for vertical adjustment; the holders have, therefore, been mounted directly on the geometric slides. Thus the optical axis is brought very near to the base line and the result of any accidental displacement in the vertical plane minimized; at the same time stability is increased and the whole apparatus made very compact.

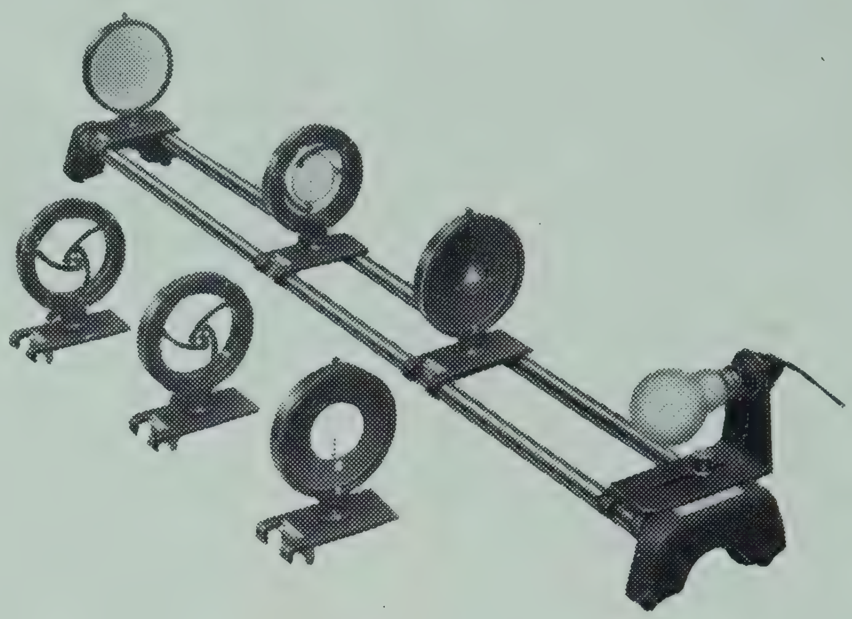


Figure 6.

The slides carry small scales graduated in millimetres, which are arranged to read against a scale in centimetres, engraved on one of the two horizontal rods on which the slides move.

With its wide range of accessories the Nivoc Optical Bench is suitable for almost all optical work. (Patent applied for.)

Nivoc Double Socket Resistance Boxes† (Figure 7). Several boxes in the Nivoc range of Resistance Boxes now employ the Double Socket contact. The Double Socket (patent applied for) consists of a socket made in two parts; the upper and lower parts are connected to the ends of the resistance coil and are insulated from each other. When the special connecting plug is placed in the socket the resistance coil is shorted out. The plug has resilient parallel sides and all plugs are completely interchangeable. Spare plugs, guaranteed to fit, can be supplied

Figure 7.

Nivoc Resistance Box. Incorporating the Double Socket Resistance Contact.

from stock. Two other features are important to the user. The distance separating the upper and lower parts of the socket is very small, and this in conjunction with the silver plated resilient plug ensures low contact resistance. (Patent applied for.)

Nivoc Unit Resistance Boxes† (Figure 8). The Nivoc Unit System allows the building up of simple or elaborate bridge or potentiometer systems from the basic units. The circuit connections are immediately evident both to student and teacher.

The system consists essentially of a range of electrical units of varying types, but all contained in compact boxes identical in size. These boxes are precision die-castings formed from a light and tough alloy which is completely resistant to atmospheric attack and mechanical misuse. The boxes are well finished in an attractive black wrinkle enamel.

The unit boxes may be securely locked to a baseboard, making a set-up transportable or available for permanent use. The whole array may be set on edge, making an ideal class demonstration arrangement. Standard baseboards are available for 3, 4 or 6 boxes, which cover almost all requirements.

Figure 8.
Units of the Nivoc System of Electrical Measurement.

It will be seen that a very wide variety of resistance networks can be assembled from a small number of basic units, and these units are always separately available if required for use in simpler experiments. The total cost of a complete set of units to build up a network does not usually exceed the cost of a corresponding

network purchased as a separate piece of apparatus; but the latter is, of course, limited to its specialized use, whereas the Nivoc Unit Boxes are instantly available for any purpose in the laboratory. Outstanding economy is thus achieved in the initial equipment, and replacement costs are very much reduced, as any damage due to accidental over-load would, in the Nivoc System, be confined to cheaply replaceable units.

Precision Magnetometer. The well established principles upon which the 'Nivoc' Optical Bench are based have been applied to the construction of a convenient and accurate magnetometer. A compass box, capable of rotation to any position, is mounted centrally on a bench consisting of two accurately parallel cylindrical rods. On these rods sliders move under geometric constraint. These sliders carry the magnets in any required position and at any required height. Robinson magnets may be so held that only one pole is effective in producing rotation of the compass box magnet, making inverse square law verification extremely simple. Coils may also be mounted on the bench for measurement of the magnetic effect of a current and for demonstration of the simple tangent and Helmholtz galvanometer principles.

Radiant Heat Bench. This is another development of the 'Nivoc' Optical Bench design. Sliders are arranged to move along parallel cylindrical rods suitably divided and engraved so that the positions of the sliders may be accurately determined. The sliders carry various radiant heat sources, diaphragm holders into which specimens may be inserted for tests of diathermancy, and a radiant heat detector consisting of a plated-wire thermopile. For demonstration work additional diaphragm holders may carry screens of heat-sensitive paper.

'Nivoc' Thermocouple. This is a rugged thermopile of the plated wire type. It has low thermal capacity and therefore quick response. It is fitted with a parabolic type of reflector which considerably increases the sensitivity, which is good enough for large scale demonstration work with the normal type of mirror galvanometer.

Demonstration Bench Stands. (Registered design.) Ordinary stands of the tripod type when used for demonstration work suffer from the disadvantage that their centres cannot approach to less than about 10 cm. from each other. In this new design the centres may be brought within 2 - 3 cm., greatly increasing their possibilities for demonstration work. The stands have an integral groove and index for supporting a metre rule, so that a simple optical (or similar) bench of any length may be quickly assembled. The stands are completely non-magnetic, which further increases their usefulness.

d'Arsonval Galvanometer. This is a standard type of d'Arsonval galvanometer which is available at a very moderate price. Aperiodic and ballistic movements are available and after removal of the case may be interchanged by detaching a single screw. The case is made in the form of a light alloy casting, further contriuting to the rugged character and attractive price of the instrument. Workmanship and finish are of the highest quality throughout. The following movements are available:

Aperiodic. Taut suspension or free suspension, 25 ohms or 100 ohms resistance.

Ballistic. Free suspension, 100 ohms resistance, period approximately four seconds.

d'Arsonval Galvanometer with Integral Optical System. (Patent applied for.) The inconvenience and difficulty of adjustment of the ordinary type of galvanometer lamp and scale are entirely removed by this instrument. The moving mirror is attached at 45 degrees to the plane of the coil, and a highly efficient optical system inset into the side of the galvanometer case projects a brilliant spot on to a screen fixed at the usual distance of one metre. After the preliminary adjustment it is impossible to disturb the relative positions of the optical unit and the mirror. The projection bulb consumes only a few watts and no appreciable heating of the galvanometer occurs. The combined galvanometer and projection unit is available with all the coil movements listed above. When reduced scale distances are essential or if extra sensitivity is required, an optical magnification device can be fitted.

Spot type Galvanometer. This is a sturdy bench instrument built around the movement of the well-known 'Nivoc' mirror and pointer galvanometer. In common with the latter instrument, it is of the taut suspension type and is self-locking when raised from the bench. The overall size of the galvanometer is 7 in. × 7 in. × $3\frac{1}{4}$ in. high, with a 15 cm. scale length.

Dip Circle 16591M†. This standard laboratory instrument has been completely re-designed. The needle now rotates between synthetic sapphire centres and the disadvantages associated with the rolling spindle type of needle are removed. The case is also entirely new and of handsome appearance. The instrument is fitted with a vertical divided circle for measurement of the dip, and a horizontal divided circle for measurement of the rotation of the instrument in azimuth. The index against which this rotation is measured also rotates and may be fixed at any point, facilitating setting of the instrument.

Stand 25

KODAK LIMITED,

The Works, Wealdstone, Harrow, Middlesex

Hydraulic Coordinate Converter. In calculations relating to colour film it is necessary to evaluate three linear functions of three variables. A computer for this purpose has been constructed using metal bellows filled with liquid. For each function three bellows, each representing one variable, are connected to a fourth. A movement of any one of the three bellows is transferred by the liquid to the fourth and the expansion or contraction of the fourth bellows is a summation of the expansions or contractions imposed on the three. The values of the variables are set by levers, and the coefficients by which they are to be multiplied by the location of the bellows with respect to a fulcrum. This enables negative coefficients to be accommodated.

Ultra-Rapid Processing Machine for Photographic Trace Recordings. (Patent applied for.) The apparatus shown is an experimental model of a processing machine designed to develop trace recordings with the least possible delay. The sensitized paper is wetted with developer and then applied to a heated drum. The light beam from the recording unit is focused on the developer-wet paper

at the point at which the latter meets the hot drum. The trace is visible in less than one second. The paper is completely dried in a further 10 seconds.

No attempt is made to fix or wash the paper. When dry, the records on 'Kodak' RP30 paper are sufficiently stable for handling even in direct sunlight for several hours. Traces that are to be preserved for future reference should be subsequently fixed, washed and dried in the conventional way.

A Simple Instrument for Measuring Friction. The instrument is designed for making rough measurements of an average coefficient of dynamic friction between a stylus of any chosen material and flat strips of any other material. The strip to be used is pulled at a suitable speed along a platform set at an angle α to the horizontal. The stylus rests on the test strip, and is carried on the end of an arm whose other end is held in a Hooke's universal joint. This coupling leaves the stylus free to swing in the plane of the test strip and platform, and also perpendicular to this plane. A resolved part of the weight of the stylus provides a normal reaction between the stylus and the test strip. A further resolved part of the stylus weight provides a restoring force against the deflection of the stylus arm from the line of greatest slope of the platform by the frictional force on the stylus. The angular deflection of the stylus arm, θ, is read off on a scale. The coefficient of friction is given by $\mu = \tan \alpha \tan \theta$.

High-Speed Film of Lever Watch Escapement. A short length of slow-motion 16 mm. film illustrates work carried out, in conjunction with the National College of Horology, on the action of a tooth and pallet stone of a club-toothed lever watch escapement. The movement of the tooth of the escape wheel along the faces of the pallet stone is shown at a magnification of approximately 70 times. The area photographed by the 'Kodak' High-Speed camera was about 3 mm. square and a special lighting system had to be used, in order to take the picture by reflected light. The film was taken at a speed of 3,000 frames per second.

Nuclear Track Recording with 'Kodak' NT-4 Plates†. The value of photographic materials in the recording of nuclear tracks is widely appreciated, and the 'Kodak' Scientific Plate range includes special plates for this purpose. Striking advances have been made in the direction of increasing the sensitivity of photographic materials to fast charged particles. The NT-4 emulsion is sensitive to particles with minimum ionizing power, with the result that particles of any energy can now be recorded. The exhibit shows some of the results which have been obtained with these plates.

The exhibit is entered with the permission of the Director of the Atomic Energy Research Establishment, the work having been carried out under contract to the Ministry of Supply.

Technique of Autoradiography†. The technique of autoradiography, a photographic method of tracer study, for biological and industrial use, is demonstrated.

For biological purposes a compound of a radioactive isotope is introduced into the organism. By means of the procedure illustrated, a radiograph is obtained from which the distribution of the element in the tissues can be determined.

For use in autoradiography a stripping photographic emulsion has been evolved, permitting resolution of the order of 2 microns.

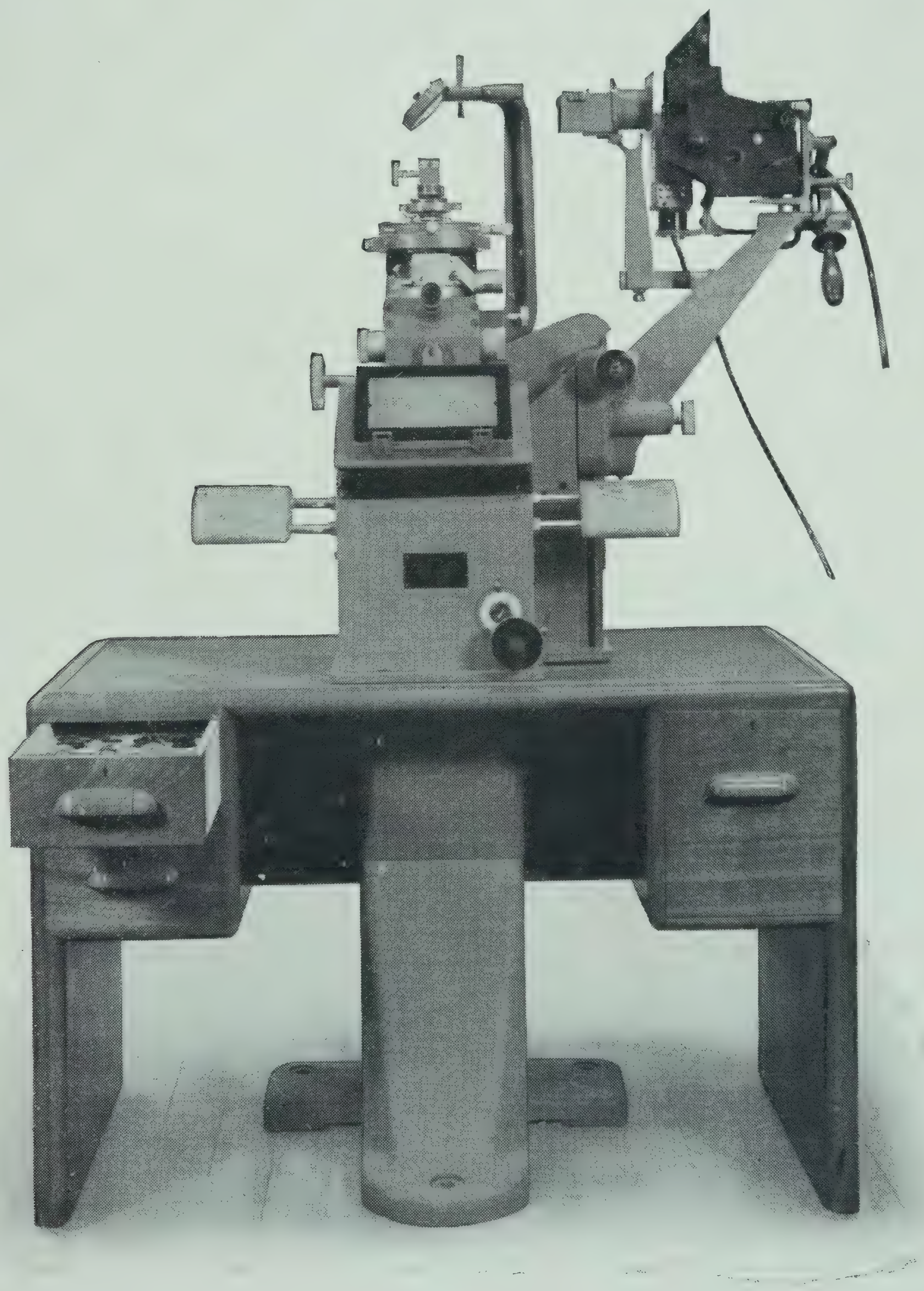
A method of checking resolution by means of radioactive test charts is shown.

Stand 26

COOKE, TROUGHTON & SIMMS Ltd.,

Haxby Road, York

Vickers Projection Microscope†. This instrument is well-known among metallurgists and others requiring a universal photomicrographic apparatus in the design of which particular attention has been paid to convenience of operation and freedom from the effects of vibration. The cabinet has now been re-designed to permit the use of the instrument from a sitting position, and arm rests are provided. The instrument is now fitted with an improved ballbearing fine focusing movement.



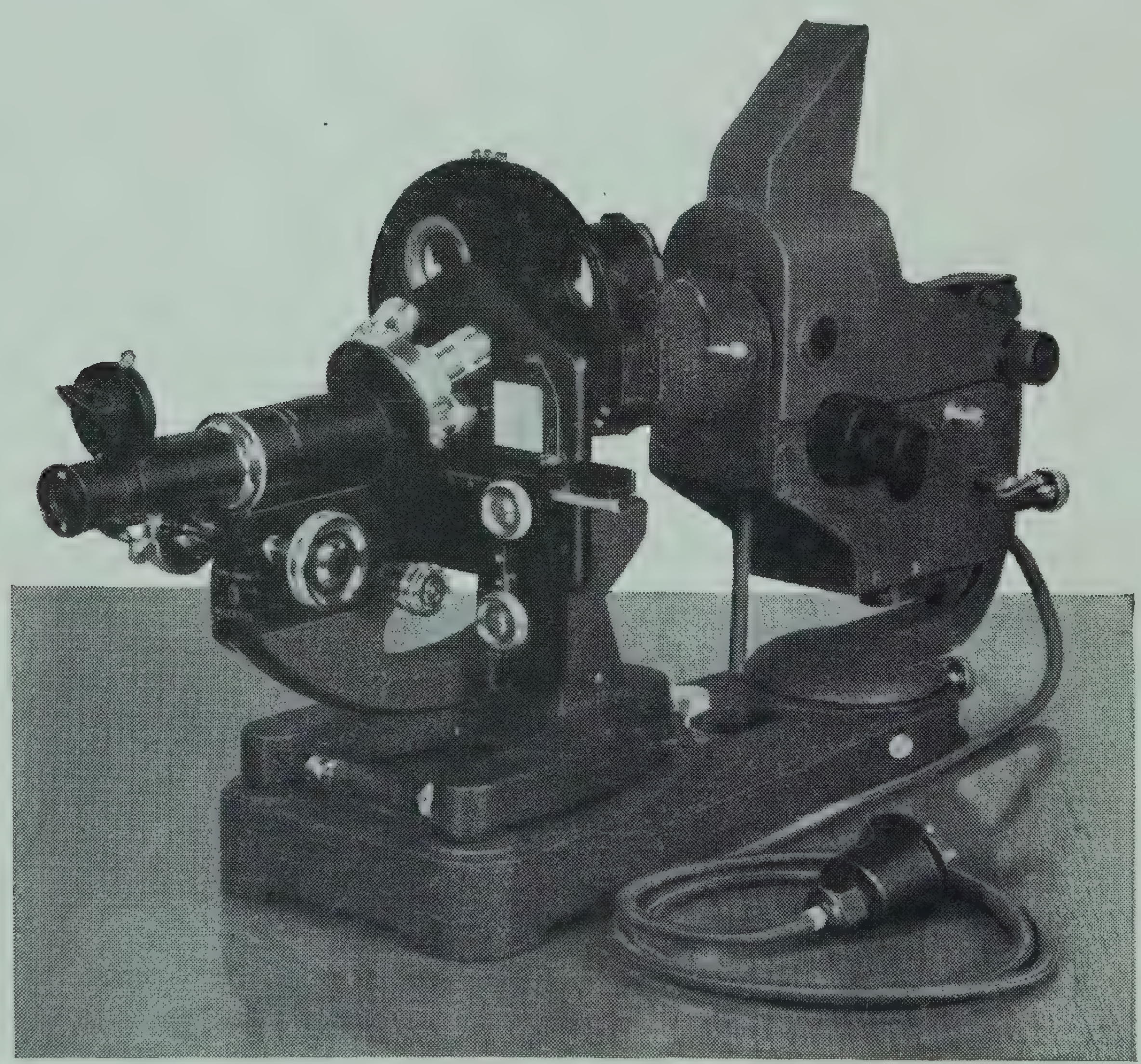
Vickers Projection Microscope with improved cabinet

Micro Hardness Tester†. This attachment is shown fitted to the Vickers Projection Microscope. It is provided with an eyepiece carrying adjustable cross-wires and measuring scales and has a diamond indenter of the Vickers Pyramid

type mounted in the front lens of the objective, thus the indent is formed precisely in that part of the specimen which is imaged on the cross-wires of the eyepiece. A load varying from 1 to 500 grammes can be applied and contact between the specimen and the indenter (achieved by means of the microscope fine focusing movement) is indicated by a signal lamp.

Tests may be qualitative (in the form of a scratch) or quantitative with a static indenter.

Micro Projector†. This instrument has been designed for the projection of translucent microscopic sections at screen magnifications up to 1500×. A clockwork driven arc lamp provides the illumination and alternative models are available for A.C. or D.C. supply. Another model is available in which a filament lamp is employed. Objectives of three different powers are provided, each having its own condenser, and revolving changers are fitted for objectives and condensers. The instrument has the usual coarse and fine focusing adjustments and a mechanical stage. A prism attachment may be fitted to the eyepiece for copying purposes.



Micro Projector

Phase Contrast Microscope with Amplitude and Phase Control. In the normal type of phase-contrast microscope a fixed retardation of $\lambda/4$ is introduced between the direct and diffracted light by means of a phase plate placed in the back focal plane of the objective. A portion (usually an annulus) of this plate is metallized so that the amplitude of the direct light is reduced (again by a fixed amount) by passage through the plate.

It has been proved that different types of detail in the microscopic object

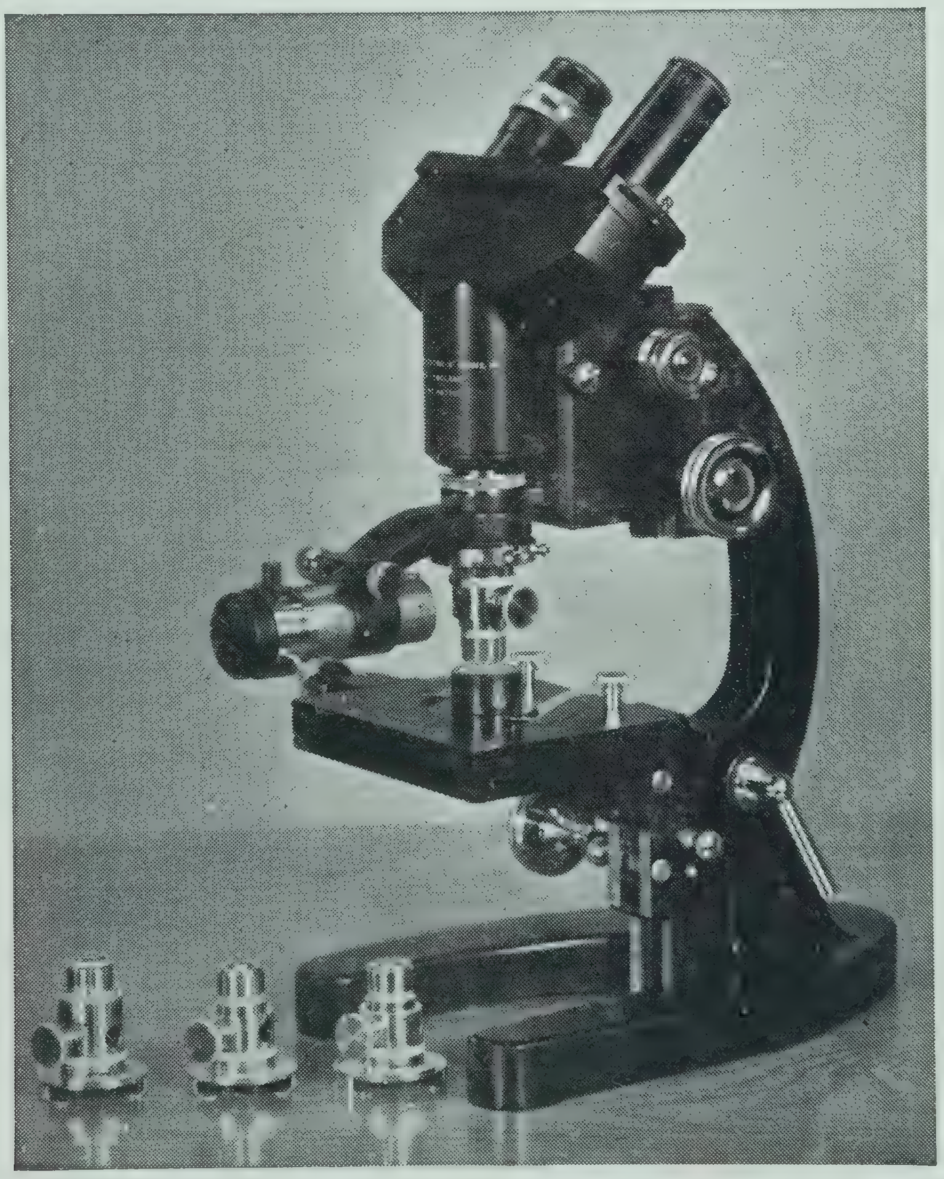
require plates having different degrees of absorption in order to give the most contrasty image and also that, particularly when examining semi-transparent or stained specimens, a retardation of greater or less than a quarter wavelength may be desirable.

In this instrument the properties of polarized light have been employed to enable both the retardation and absorption of the phase plate to be varied at will.

Phase Contrast Equipment for Opaque Specimens†. This equipment has been designed for use with incident light for the examination of opaque specimens. (See Figure.)

The illuminator tube carries the annulus which is used for all the objectives. The annulus can be moved out of action and is provided with a centring adjustment. The illuminator tube also contains a condensing lens and is fitted with a variable power adjustment whereby the phase plates in objectives of different powers may be made to coincide with the single annulus.

Each objective is fitted with an adjustable incident illuminator plate and the necessary phase plate.



Phase Contrast Equipment for Incident Light

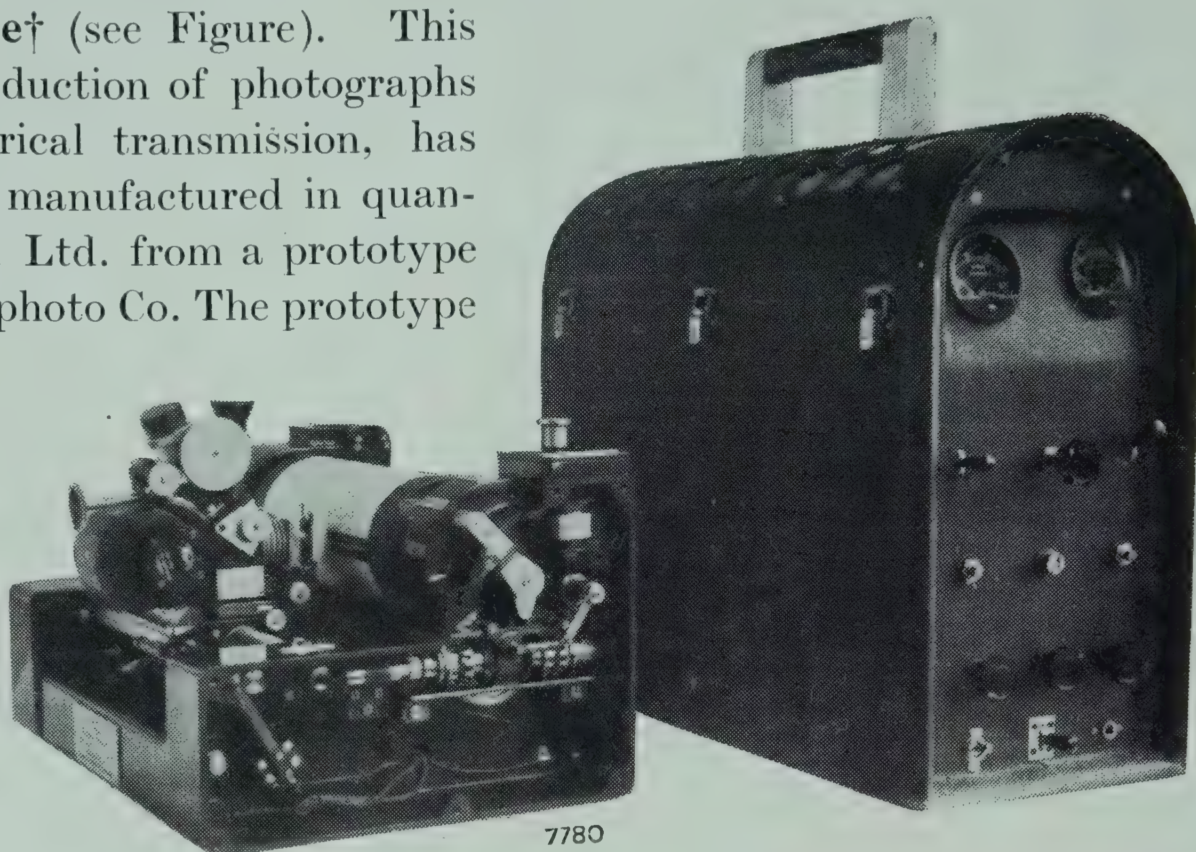
Stereoscopic Microscope for Examination of Textile Fabrics†. This consists of the usual type of stereoscopic microscope in which the plate-glass stage is replaced by a stage having a mechanical lateral movement. A removable glass plate carrying two or three sets of scales can be superimposed on the fabric under examination.

Stand 27

BARR & STROUD Ltd.,

Caxton Street, Anniesland, Glasgow, W.3
and 15, Victoria Street, London, S.W.1

Telephoto Machine† (see Figure). This machine, for the reproduction of photographs by long-distance electrical transmission, has been re-designed and manufactured in quantity by Barr & Stroud Ltd. from a prototype made by the Unit Telephoto Co. The prototype showed a marked improvement on other machines in reducing the optical beam-length — to about one-tenth of that generally used — so that the machine was not only considerably smaller but portable.



Telephoto Receiver and Amplifier

In the Barr & Stroud design further improvements have been made in general appearance, finish and mechanical construction.

The apparatus consists essentially of a Transmitter, a Receiver, and Electric Amplifier and Control Units, and accommodates photographs up to 10 in. × 8 in. The photograph to be transmitted is wound on a drum in the Transmitter, rotatable at a uniform speed, and is scanned in a continuous close spiral by a beam of light which is concentrated down to a small area at the picture surface and the reflected strength of which varies in accordance with the tone values of the picture. The portion of the light beam usefully employed in scanning measures only 0·01 in. × 0·008 in. and is made thus small for good detail in reproduction. By means of a photoelectric cell the light reflected from the small scanned areas on the photograph is converted into electric signals which vary in strength and are a function of picture tone. The modulated signals are amplified and control an oil-damped mirror oscillograph at the receiver so that deflection of the mirror displaces the beam of light from a fixed source. The reflected beam is projected by a lens system so as to focus at the surface of photographic paper, wound on a drum which runs in synchronism with the drum of the transmitter ; and a special mask, placed at the projector lens, is so shaped that for a given beam displacement the light passing through to the lens is of the correct amount for an exposure of the paper which will correspond in tone with the small portion of the picture producing the signal.

The Transmitter and the Receiver are electrically connected by line wire or radio. For transmission of the signals to the Receiver a carrier wave is generated, with a frequency of 1326 c/s., and modulated in amplitude according to picture tone.

Optical Filters, Beam Splitters and other Devices†, produced as a result

of recent advances in the deposition of thin films on glass by the high vacuum process. The exhibits show some applications of the comprehensive range of such products.

High Vacuum Film Depositions† on materials other than glass. The examples shown were recently undertaken by Messrs. Barr & Stroud Ltd., in conjunction with industrial and college research establishments engaged on problems in nuclear physics and other work requiring thin films of pure materials.

Stand 28

AVIMO Ltd.,

Taunton, Somerset

The Avimo Continuous Film Recording Camera Type 70/200/300†. This camera has been designed for high speed continuous film recording in connection with any standard cathode-ray oscillograph or group of tubes mounted to suit specific requirements.

The general specification of the camera is as follows:

- (*a*) 200 ft. film capacity 70 mm. perforated to BSS.677.
- (*b*) Film speeds of 300 ; 150 ; 75 ; 10 ; 5 and 2·5 inches per second.
- (*c*) A $2\frac{1}{2}$ in. f/1·9 Anastigmat Lens.
- (*d*) 24 volt power supply.
- (*e*) Daylight loading cassettes.

General Description. The camera consists of a light alloy casting, one portion housing the film spools and cassettes, 4 in. diameter film sprocket, two film guide rollers and an automatic tensioning brake on the top spool which is governed by the variations in tension of the film between the feed spool and the sprocket.

A time marker lamp is incorporated which gives a small triangular mark on one edge of the film.

The other section of the casting houses the mechanism which consists of a 24 volt $\frac{1}{4}$ H.P. motor driving through a high and low speed gear range to a three-speed gear box giving the range of speeds as quoted at (*b*).

The main drive sprocket is connected to the gear box by means of a clutch which enables the mechanism to be maintained at its normal running speed, thus allowing the film to be set in motion and reach its desired running speed with the minimum of waste, as the only inertia to be overcome is that of the sprocket and feed spool.

All the mechanical controls are situated on a panel at the rear of the camera and the electrical connections are made through a 6 pin and 8 pin plug and socket on the back of the unit.

All the electrical controls of the camera are catered for by a separate control unit and provide interconnection between the cathode-ray tubes and camera.

Provision is also made for remote control of the complete equipment by the use of a 6 pin plug on the control unit.

Finish. Camera and Control Unit—Stove cream enamel, all controls in bright chromium plate.

Dimensions and Weight. Camera — 15 in × 17 in. × 11 in.; 54 lb.
Control Unit — 12 in. × 9 in. × 9 in.; 10 lb.

TECHNOLOGICAL RESEARCH

The 'Avimo' 35 mm. 16 in. Self-loading Drum Camera and Electronic Controls†. The camera unit consists of a 16 in. diameter drum mounted in a suitably designed main casting with the film wound round the periphery of the drum. When one strip is exposed, it is automatically reloaded, and with the film capacity of 100 ft. plus an 8 ft. leader and trailer, approximately 24 exposures of 50 in. length are possible.

A 4·5 in. f/1·9 lens is fitted which is adjustable to suit different applications, and a reflex focusing system ensures correct positioning of the lens.

A commutator system is incorporated to ensure the correct relationship between the Camera Drum and cathode-ray tube trace.

There are no controls on the Camera, these are centralized on the Electronic Control Unit.

The main features are:

(*a*) A form of Electronic Speed Control to vary the speed of the Drum giving a maximum speed of 3,000 in/sec. approximately.

(*b*) Operation of the rewind mechanism after exposure.

(*c*) Electronic control of the beam of the cathode-ray tube, the trace of which is being recorded.

Dimensions: Camera — 23 in. high × 28 in. base diameter.
Control Unit — 27 in. long × 24 in. × 24 in.

The Avimo 35 mm. Single Shot Camera Mk.II†. This instrument has been designed for recording a stationary trace on a cathode-ray tube to give it a reproduction of one inch square. It is suitable for use with any standard cathode-ray tube oscillograph or for any special applications, a suitable connecting hood being designed to suit the customer's requirements.

The essential features of the Camera are as follows:

(*a*) A pressed sheet metal case which houses the complete operating mechanism and lens.

(*b*) A simple hand operated shutter for time exposures.

(*c*) A built-in guillotine enabling the film to be cut at any desired position is operated by a small button, and the loading cassette removed for processing.

(*d*) Film capacity 16 ft. in pressed steel daylight loading cassettes, giving 160 one inch square photographs.

(*e*) Film movement frame by frame by the movement of a small lever on the side of the camera through 60°. This ensures that no film is wasted due to insufficient movement of the film causing a double exposure or to the film being moved a greater distance than necessary.

(*f*) Interchangeable lenses are available. The Avimo 1¼ in. f/4·3 for normal recording work and the Avimo 1¼ in. f/1·9 for special requirements.

(*g*) An exposure indicator giving the number of exposures made which counts up to 1,000, or alternatively, can be reset at any time.

(*h*) Easy connection is provided for fixing the hood to the camera which can be replaced should the instrument be required for use with several different oscilloscopes.

(*i*) The instrument is suitable for using 35 mm. unperforated film or

paper, small projecting pins in the take-up roller engaging in the film or paper, perforating it and thus moving it the desired amount.

General Construction. The film transport mechanism is simple in design and requires no attention or adjustment. The film is held against the front pressure pad by a spring loaded gate carrying a ground glass screen which can be used for focusing purposes by removing the small knurled screw at the rear of the camera.

The physical dimensions of the camera are 7½ in. long ; 4 in. wide ; 5 in. high. Weight : 4¾ lb. when loaded.

The general finish of the instrument is : All interior surfaces Hess intense black ; external finish stoving enamel in brown and cream and all operating controls in chromium or natural aluminium.

The Avimo Continuous Multi-Channel Cathode Ray Tube Camera (15-Channel)†. The 15-Channel Recording Camera combines in one unit the Camera and fifteen 1½ in. (37 mm.) diameter Cathode-ray Tubes. The fifteen tubes are disposed, eight on one side of the camera and seven on the other, with the screens of the tubes facing in the same direction as the twin 3 in. f/2·9 Dallmeyer lenses. The latter are mounted at an angle of 36° to each other, and adjustable mirrors, one for each tube, are arranged in two batteries to reflect the traces accurately along the axis of each lens. The traces are focused on to a vertical zero line and the tubes are so staggered as to allow the accommodation of the fifteen traces across a space of 60 mm., i.e., the effective recording width of the 70 mm. film used.

The capacity of the spools is 100 ft. of 70 mm. film and these are housed in a chamber in the centre of the unit, the film gate being pressure loaded, and fitted with a transparent window, on which is engraved a graticule formed of vertical and horizontal lines, indicating the limits of the traces. A low power neon lamp illuminates the graticule when the beam test switch (mentioned below) is pressed.

The film is driven horizontally from a sprocket connected through a six-speed gear box to a small A.C. motor governed efficiently at 3,000 r.p.m. The six speed range gear box allows film speeds of 1, 2½, 5, 10, 25 and 50 inches per second (25, 62·5, 125, 254, 625 and 1,250 mm. per second).

A film meter for recording the footage of unexposed film on the take-off spool is also provided.

Integral with the Camera are two Argon filled discharge lamps which, operated by an external circuit, give time marks on the film. One mark is a small dot on the lower edge of the film and the other is a thin line across the whole width.

The analysis of traces induced in various types of structures, due to vibrations or variations in load, such as those met with in air frames, bridges, etc., become a much simpler matter using the 15-channel Camera. The pick-ups used for this purpose could be strain gauges and the output voltage amplified by A.C. or D.C. amplifiers and fed to the cathode-ray tube Y plates.

Analysis of vibrations in multi-cylinder engines in a similar manner to the above is also simplified.

Torsional stresses and vibrations in propeller shafts, temperature recording in engine cylinders, mains supply changes, determining variations in light intensity using photoelectric cells, for recording variations in pressure in high-speed engine

cylinders and exact time of explosion when using various grades of fuel, or determining flame spread period in diesel engines : the above are some of the multitudinous applications of the 15-channel Camera.

If the Camera is supplied with auxiliary electronic equipment, i.e., amplifiers, E.H.T. power pack, integral pulse generators, etc., the Unit is normally built as a console with the Camera fitted on top.

There is a smaller version of the 15-channel Camera, the principles of which are the same, but it comprises 6 cathode-ray tubes instead of 15, and uses 70 mm. film.

The Universal Oscillographic Recorder†. This instrument has been designed to suit the specific applications of the Ministry of Supply for armament flight trials but it has, however, many uses in other spheres of research where a small instrument is essential.

The general specification of the instrument is as follows :

- (*a*) Single and twin lens mounts using $1\frac{1}{2}$ in. f/1·9 anastigmat lens.
- (*b*) 100 ft. film capacity 70 mm. perforated to BSS.677.
- (*c*) Speed range by means of a gear box to give film speeds of $1\frac{1}{2}$, 3, 6, 12 and 24 inches per second.
- (*d*) Facilities for daylight loading are provided and an interlock whereby the cover cannot be removed until the cassettes are closed.
- (*e*) A built-in guillotine for cutting the film should it be desired to remove small lengths.
- (*f*) A single time marking lamp to mark the film with a small triangle at predetermined intervals from a suitable external source.

The complete unit has been designed to withstand all normal aircraft vibrations including those caused by rocket and cannon fire and it is stressed to withstand $\pm 3g$ in any direction.

Finish. Camera exterior surface stove grey enamel, interiors urface Hess intense black, controls bright chromium. Dimensions 8 in. × 6 in. × 5 in. Weight approximately 12 lb. loaded.

The Avimo Focal Plane Cameras for use with Observatory Microscopes, Type 35/·2/0†. This unit consists of a set of twelve cameras which were developed for Sir Howard Grubb, Parsons & Co., Ltd.

The object of the equipment is to enable photographs to be taken of the meridian circles on observatory telescopes in order to reduce the time element involved in plotting stars in declination.

The Cameras are designed so that the film lies in the focal plane of a × 5 microscope which acts as the lens and gives a photograph of six divisions of the meridian circle with a 5 to 1 enlargement.

The Camera consists of a mechanism plate which carries the film transport mechanism, 16 ft. capacity daylight loading cassettes for 35 mm. film and a mounting for the microscope. The complete assembly is housed in a light sheet metal case $6\frac{1}{4}$ in. long × $3\frac{3}{4}$ in. high × $2\frac{1}{2}$ in. wide. A common control is provided for transporting the film on each batch of six cameras by means of a wire cable.

The photographs are taken by remote control by pulsing a lamp for a predetermined period which illuminates the meridian circle.

The Bore Hole Camera†. This is an apparatus whereby a complete photographic record may be obtained of the internal surface of a hole extending downwards into the earth to a depth of about two miles or perhaps more.

The elements are :

1. A cable drum winch above ground, having associated with it the controlling arrangements for the precise lowering of the Camera 'shell' and the synchronizing of the illumination and film exposure at pre-determined sequences.

2. A cable which functions as a support for the Camera 'shell,' and also as a medium for the conveyance of an electrical supply to the illuminating and camera operating mechanism, and in addition for the conveyance of the necessary electrical control impulses.

3. A Camera 'shell' of an approximate diameter of $4\frac{1}{2}$ inches and a length which is of the order of 12 ft. (depending on the depth of the bore hole and the corresponding film capacity required). The Camera 'shell' contains a nose chamber with bellows for equalization of pressure, a window and reflector chamber through which the complete walls of the bore hole are photographed, a lamp chamber, a camera chamber, a film storage chamber, an electronic control chamber, and a cable sealing chamber.

Specimen photographs will show that the portion of the bore hole visible at one time, i.e., constituting a short cylindrical surface, is photographed directly on to the film ; and that a true reproduction of the bore hole surface is afterwards projected and printed from the developed film.

The apparatus permits a true photographic record to be obtained of the internal surface of any deep hole into the earth, provided that the hole is empty or occupied only by a transparent liquid.

Stand 29

STANTON INSTRUMENTS Ltd.,

119, Oxford Street, London, W.1

Model B.A. 6† (Figure 1). A prismatic reflecting aperiodic balance with a loading attachment permitting loads up to 200 gm. to be placed by external means and read accurately to ± 0·0001 gm. An exceptionally clear reading screen is another important feature of this instrument. The complete set of weights supplied with the balance is made from 25/20 stainless steel — absolutely non-magnetic and non-corrodible. The arrangement of weights is such that the load is placed evenly at all times.

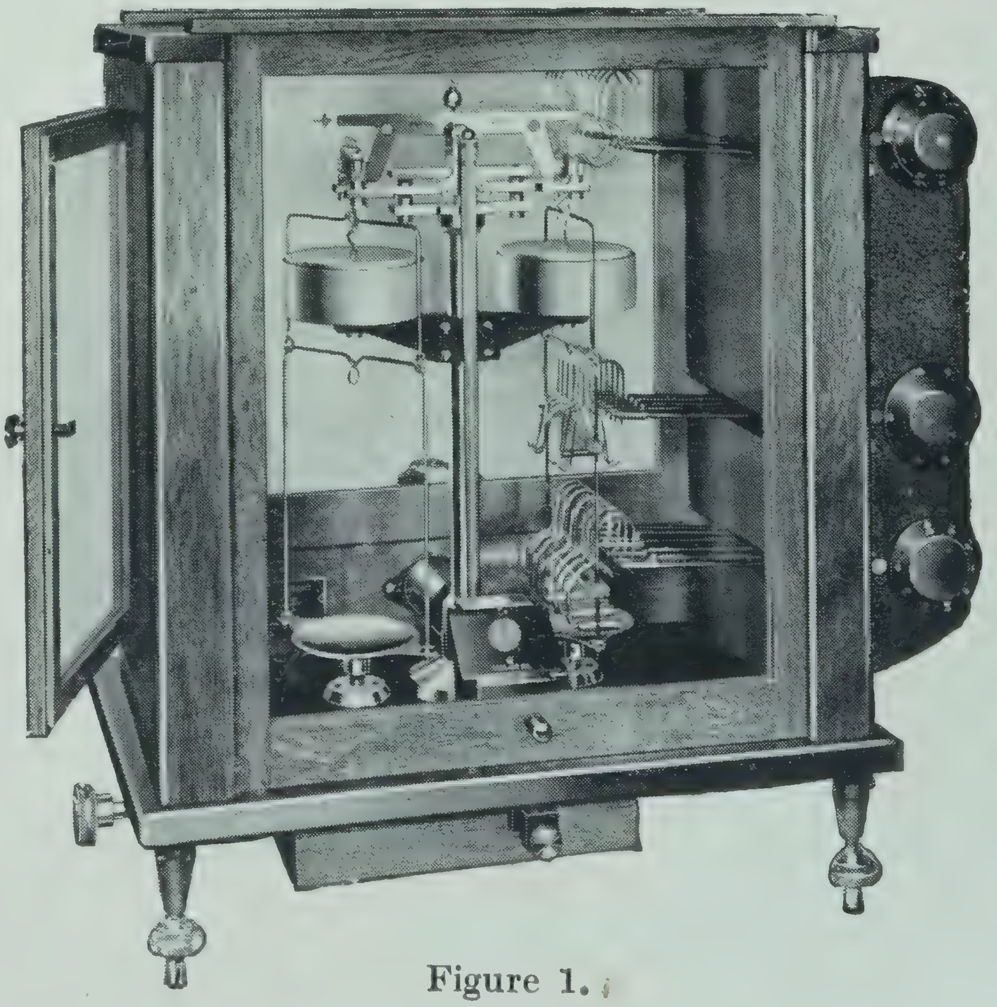


Figure 1.

Each individual weight is adjusted to well within the N.P.L. Class A tolerance, and special care is taken to avoid cumulative errors. The loading attachment can be supplied fitted to the left or right-hand side of the case, as desired. This is the first balance with loading attachment up to 200 gm. to be made in Great Britain. It is fitted throughout with synthetic sapphire (corundum) bearing planes.

Microgram Balance†. A most carefully designed balance constructed primarily for adjustment of weights to extremely high standards, this instrument has a sensitivity of $\pm$ 1 microgram with a maximum load of 5 gm.

1-kg. Precision Balance†. This balance fills a very urgent need for high accuracy at heavy load. Rigid supports are built in to give solidity and smoothness to the beam arrestment mechanism. The beam is an exceptional example of exquisite craftsmanship and design. An accuracy of 0·1 mg. is attainable with this instrument.

10-kg. Precision Balance†. This balance was made primarily for the adjustment of highly accurate weights, but is now being fairly widely used in various rôles. It can be fitted with automatic loading attachment to become a special-purpose balance for work on radioactive materials, or in any capacity where high sensitivities are required. It will give reproducibility to the order of 5 mg. Included with the balance is a special set of brass weights, heavily silvered and rhodium plated, and adjusted to the N.P.L. Class A tolerance.

Model M.C. 1/A† (Figure 2). An aperiodic micro-balance with capacity 30 gm. and sensitivity 0·01 gm., i.e., 1 graticule division. It is possible to read accurately to $\pm$ 3 micrograms. Nickel-chrome ring riders up to 1 gramme can be loaded by external means, and the beam is isolated from the lower half of the balance by means of a glass shelf. The beam arrestment mechanism is fitted with agate pivots, and is the 'double-action' type in which the load is placed on the end knife edges before the centre. This helps in achieving an exceptionally smooth 'set-off'. The reading screen is very clear to read, and is adjustable from outside the case.

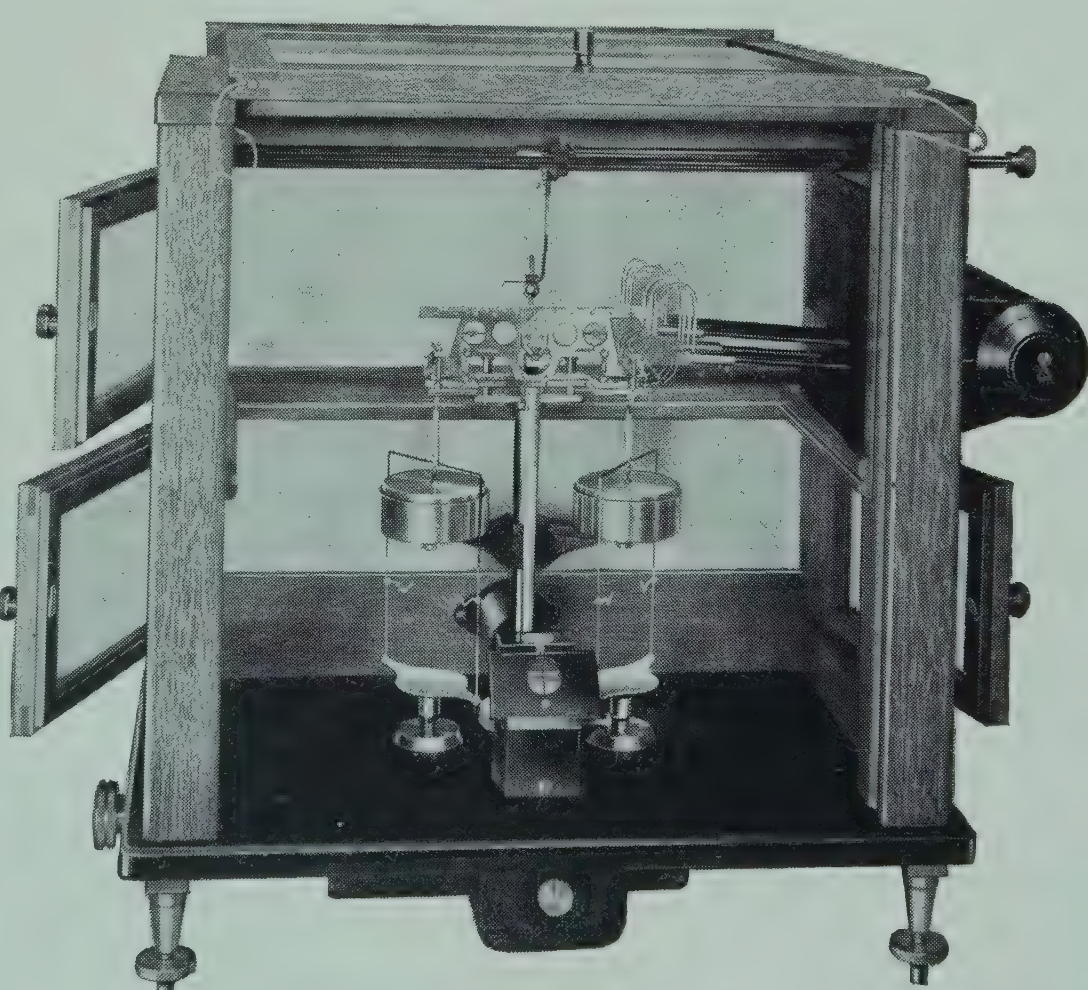


Figure 2.

Stainless Steel Weights†. The set of weights is made from Immaculate 5

Stainless Steel, which in many ways is an ideal material for analytical weights, being absolutely non-magnetic and non-corrodible.

The Set has one or two novel features. The series of weights is 50, 30, 20, 10, 5, 3, 2, 1, etc., as distinct from the more orthodox 50, 20, 10, 10, 5, 2, 1, 1, 1. The advantages, apart from the fact that there is one less weight, are (*a*) the need for differentiation between similar weights does not arise, and (*b*) many results can be obtained using fewer weights, i.e., 30, 10, 5, 3, 1 gm. = 49 gm. with 5 weights, against 20, 10, 10, 5, 2, 1, 1 gm. = 49 gm. with 7 weights, with the consequent diminution of cumulative error. The fraction weights are also of a new design, being made from wire, with the geometrical form of the weight indicating the denomination. Thus, a five-sided figure = 0·5 gm., a three-sided figure = 0·3 gm., etc.

Stand 30

UNICAM INSTRUMENTS (CAMBRIDGE) Ltd.,
Arbury Works, Cambridge

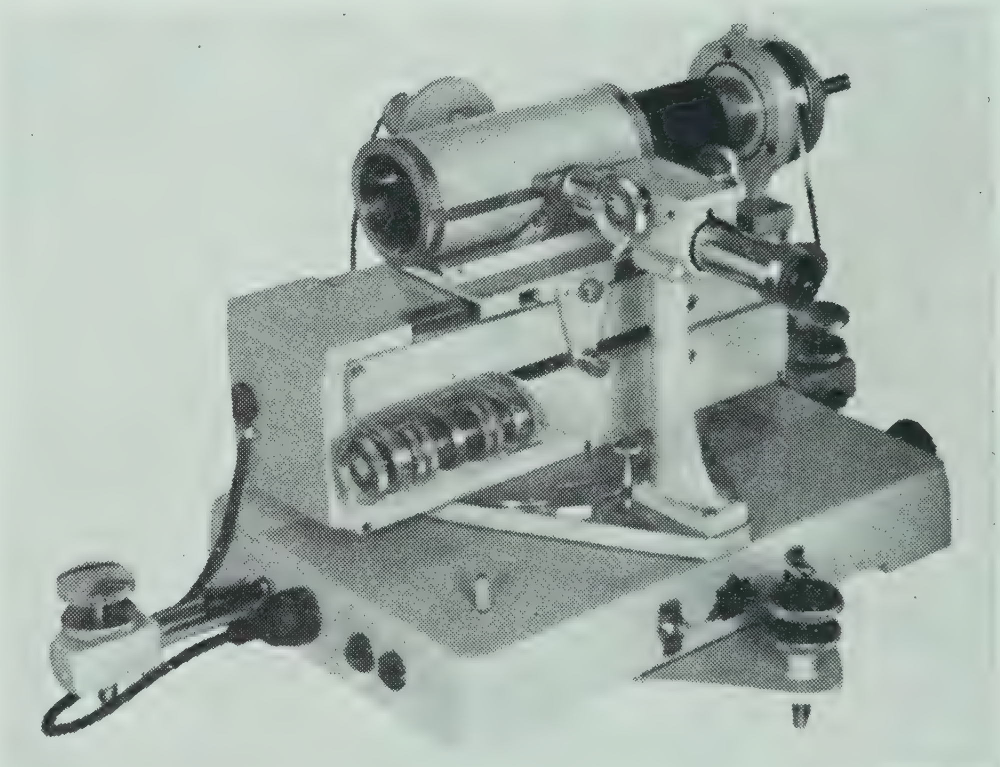


Figure 1.

Single Crystal Weissenberg Goniometer† (Figure 1). This Weissenberg goniometer consists of a goniometer head capable of rotation about an axis which is coincident with the axis of a cylindrical camera, and the movements of the head and camera are coupled together. The goniometer head carries the standard Unicam graduated arcs and slides and may readily be detached from the instrument. The standard camera is 57·3 mm. in diameter and is carried on a slide which moves along the upper base of the instrument in V-grooves. (A camera of 60 mm. diameter can be fitted as an alternative if specially required.) A synchronous motor within the upper base rotates a screw which in turn translates the camera carriage. The rotation of the goniometer head is achieved by means of a spring-loaded steel tape coupled to the carriage driving nut. The translation of the camera, and/or the rotation of the crystal, can be pre-determined by adjusting stops on the short traverse-screw under the Perspex cover on the front of the instrument. Any angle of oscillation of the crystal between a few degrees and 200° can thus be obtained. The translation of the camera when coupled to the rotation of the crystal is 1 mm. per 2° rotation. For taking oscillation photographs during the initial setting of the crystal the camera slide may be disconnected from the driving nut. Conversely, the camera may be translated while the goniometer head is stationary.

For taking inclination Weissenberg photographs the upper base is pivoted on the lower base and can be rotated up to 30° on either side of the normal setting or up to 40° if a special bracket is used. Further, the upper base may be mounted vertically if required, on a special right-angle mount which is bolted to the lower base. The lower base can slide sideways on a rail and platform which carry the levelling toes. This permits rapid alignment of the collimator in front of the x-ray tube. A microscope is attached to the instrument, and collimators of standard 1 mm. and ½ mm. diameter are provided.

Summary of Operational and Mechanical Features.

1. Uniformity of motion of the camera and goniometer head, achieved by means of synchronous motor and accurate mechanical construction not involving spur, worm or bevel gears.
2. Quietness of operation and freedom from wear of moving parts, obtained by a carefully calculated rate of movement which is satisfactory for all practical exposures. One complete traverse takes 7½ minutes.
3. Great range of movement of the upper base, permitting an almost complete survey of all possible x-ray reflections from a crystal with one setting.
4. The camera may be arranged to hold up to five films together if required.
5. The instrument may be moved out of the x-ray beam without upsetting the alignment.
6. The goniometer head and the camera can operate independently of each other when required.

Unicam Geiger Counter Spectrometer for X-Ray Analysis of Single Crystal and Powder Specimens. This instrument comprises the following components :

Spectrometer Base with two motor driven horizontal rotating movements reading to within one minute of arc.

Vertical Circle and goniometric Crystal Holder suitable for Laue and Rotating Crystal Methods.

Monochromator with variable slits and filters.

Geiger Counter Unit with mounting bracket capable of vertical angular movement of 30° above and 5° below horizontal, the horizontal movement being through an arc of 150°.

Electronic Amplifier and scaling unit.

Other Unicam Crystallographic instruments to be exhibited are the High Temperature Powder Camera for investigations up to 1,000°c. and a Two Circle Optical Goniometer in which the two glass circles, each reading to one minute of arc, are both viewed together in the one eyepiece.

Unicam Photoelectric Quartz Spectrophotometer for Visible and Ultraviolet Investigations† (Figure 2). This instrument is designed for the rapid identification, qualitative and quantitative determinations of chemical substances by the percentage absorption or transmission of light at wavelengths in the range 200 – 1,000 millimicrons. The basic instrument comprises a monochromator formed of a very rigid Meehanite box casting containing the optical components, the box being sealed to exclude dust and moisture.

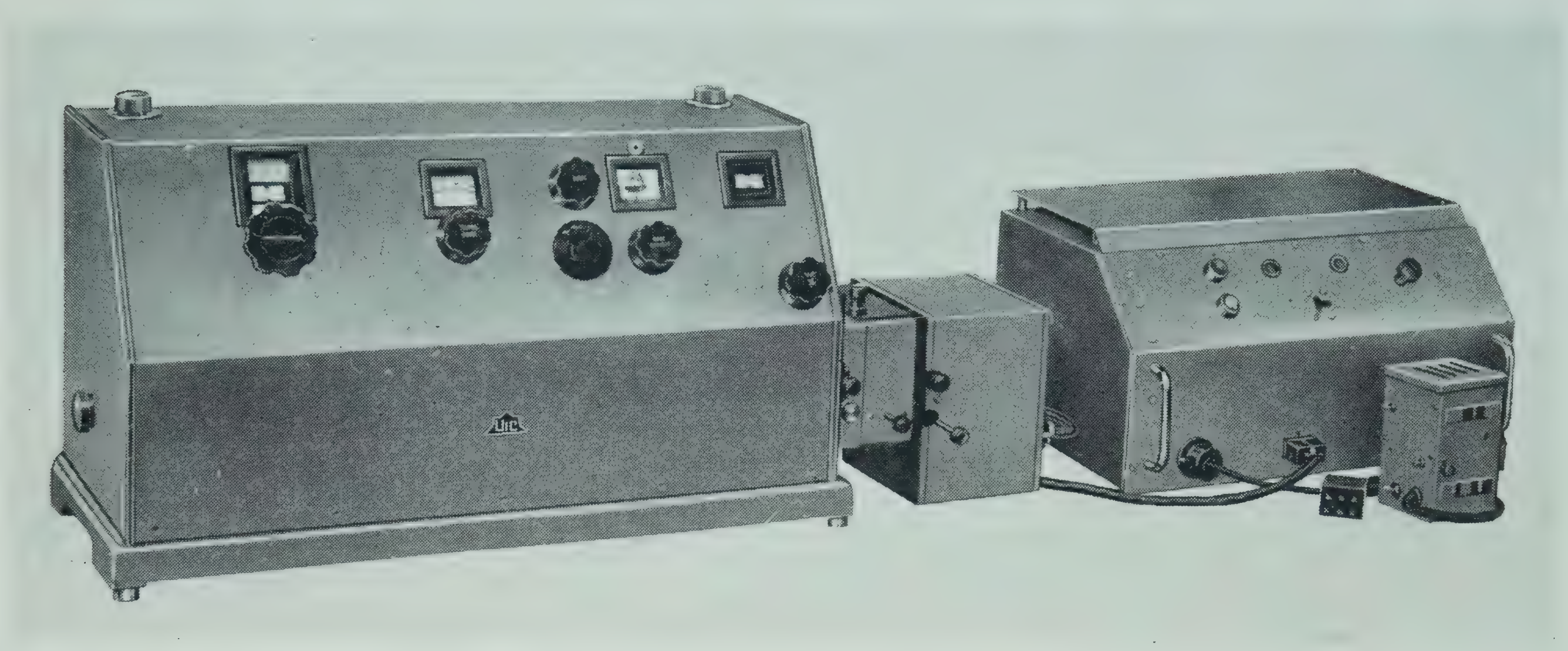


Figure 2.

One end plate of this monochromator mounts the slit mechanism which is on the inside and therefore protected against damage, the entry and exit holes being sealed with quartz windows. The outside of this plate is drilled suitably and fitted with locating pins to receive the interchangeable light sources, the filter holder, cell compartment and other accessories.

An outer case with a conveniently sloping panel contains all the electrical controls. On the panel are the knobs which adjust wavelength, transmission, slit width, dark current control and sensitivity control, and a four position switch.

The compartment containing the photocells and amplifier valves is a light-tight desiccated box attached to the slit plate by means of four knurled-head thumb screws and is easily detachable.

The power pack for the hydrogen lamp supply is a separate electronically stabilized unit.

The change over from tungsten lamp to hydrogen lamp is provided for by quickly interchangeable lamp housings.

The absorption cell holder in its separate compartment is designed as a four place holder to take cells up to 40 mm. light path, and spacers are provided for 2, 5, 10, 20, 30 and 40 mm. Other cell compartments for the accommodation of longer liquid or gas cells, and for other techniques, can be supplied upon request.

Diffraction Grating Spectrophotometer† (Figure 3). This instrument has been designed for the measurement of Transmission

Figure 3.

and Optical Density of sample solutions at wavelengths within the visible region of the spectrum. The Dial Calibrations are from 400-700 millimicrons, and the band width approximately 35 millimicrons. For power supply a 12 volt battery is required. Alternatively this spectrophotometer may be operated from suitable A.C. mains if it is used in conjunction with a constant voltage transformer.

The main assembly of the Unicam Diffraction Spectrophotometer includes the following components :

1. Pre-focus Exciter Lamp.
2. Condensing Lenses between which is mounted a Diffraction Grating.
3. Monochromator exit slit adjacent to the test cell aperture which in turn is located in front of the Photoelectric Cell of selenium barrier layer type. Between the test cell aperture and the photocell is a fixed compensating filter.
4. Spot Galvanometer with taut suspension and zero adjustment. A removable dual purpose scale is fitted, for linear and logarithmic readings. Specially divided interchangeable scales can be provided to suit users' requirements.

Golay Infra-red Detector†. This detector comprises essentially two parts, a pneumatic circuit and an optical system.

The pneumatic circuit begins with an air or gas-filled radiation receiving cell, in the centre of which is a radiation absorbing membrane. The expansion of the gas resulting from infra-red illumination of this membrane is piped through the central duct to the detecting membrane, always under tension, which performs the function of a flexible mirror, and forms the link between the pneumatic circuit and the optical system. The pneumatic circuit is completed, through the two side ducts, to the discharge or dead end cell which is ring shaped and surrounds the radiation receiving cell. The optical system comprises a photocell exciter, a compound of condensing lenses, a line grid, the detecting membrane, a small meniscus lens near the detecting membrane, and a photocell.

The Golay detector has an 'R.M.S.E.N.I.' (root mean square equivalent noise input) of 5×10^{-11} watts when working into an electronic recorder and using the chopped beam method (10 c/s. chopping rate). The sensitive element is $\frac{1}{8}$ in. diameter, with a slight decrease in sensitivity near the edge.

This detector is robust and stable. Photoelectric pre-amplification of 40 db. ensures that the overall performance is independent of valve noise. The equipment includes the detector, infra-red beam chopper and A.C. electronic amplifier with synchronous rectification.

Stand 31

W. R. PRIOR & CO. Ltd.,

13 Northgate End, Bishop's Stortford, Herts.

"Universal" High Power Binocular Microscope†. This is a microscope designed to meet the need of the worker who must have an instrument of the highest possible efficiency. The stand itself is rigid and well balanced, and is fitted with both binocular and interchangeable monocular bodies, square built in mechanical stage, with graduated scales reading by vernier to 0·1 mm., revolving nosepiece, and rackwork focusing and centring substage. The fine adjustment,

of vertical lever construction is scaled to read by graduated drum to 0·002 in.

This model is equally suitable for research work, photomicrography, or projection.

"Research" Microscope†. This monocular instrument, of heavy construction, is primarily intended for the advanced worker. Its features include an extra wide body tube of 2 in. diameter, a square built in mechanical stage, having faultless travel in the horizontal direction of 60 mm. and in the vertical direction of 25 mm., graduated drum to the fine adjustment divided to read to 0·0002 in., revolving nosepiece, and rackwork focusing and centring substage.

This model is also equally adaptable for either visual, projection, or photomicrographic work.

Laboratory Microscope, Model RPD†. This microscope, which has been completely redesigned, is an ideal instrument for general laboratory and routine work. It is available with either a plain square stage, or with an attachable mechanical stage. The substage focusing movement on this stand is by rack and pinion actuated by two milled heads, located on either side of the limb. The substage fitting is also provided with a centring mount.

Students' and Medical Microscope, Model DSF†. The DSF microscope, which is now available in a completely remodelled form, finds considerable acceptance with students, medical practitioners, and educational authorities. Although when initially supplied, it is frequently fitted with a minimum of essential equipment, it can nevertheless be built up into a most comprehensive outfit.

Low Power, Wide Field Binocular Microscope, Model WF†. This instrument has been designed to meet the increasing demand for a microscope having good stereoscopic vision, a wide field of view, and a long working distance. It provides a range of magnification between 4·2× and 60 ×. The binocular body can be mounted on a variety of stands including a horseshoe foot with double reflecting mirror, a long arm stand on heavy tripod foot, and a long arm stand with table clamp fitting.

Inverted Microscope†. An example of one of our microscopes of new design. This model was produced primarily for special research work, in connection with marine biology. It makes a special appeal to the specialist worker engaged in the examination of wet specimens. All accessories used on this stand such as eyepieces, objectives, condenser, and mechanical stage are standard items from current production.

School Microscope†. The School Microscope has been introduced to meet the need for a reliable yet relatively simple instrument of medium power. A range of magnification is provided between 30× and 175×. Focusing is by means of a fine adjustment which moves the objective up and down in a vertical direction. The field of vision does not rotate during this focusing operation.

Schemmel Microscope†. A microscope specifically designed for depth measurement of printing blocks and matrix. Its range is accurate up to depths of 50 thousandths of an inch, in 1/10,000 in. readings.

The basic design is readily adaptable for many industrial uses, such as the accurate measurement of wires, plates, etc., by the simple process of a difference in vernier readings from (in the case of a fine wire) the top and bottom of the wire.

Stand 32

OPTICAL WORKS LIMITED,

32, The Mall, Ealing, London, W.5

Aluminized Spherical Mirrors in Adjustable Mountings†. These instruments are being produced primarily for use in the study by Schlieren test methods of airflow in wind tunnels. The mirrors are of very high optical quality, being checked during manufacture by the Foucault knife-edge test. The mounts are of robust design, with micrometer adjustments about the horizontal and vertical axes. A detachable metal cover is provided to protect the mirror when not in use. These mirrors are made in three sizes 18 in., 12 in. and 8 in. in diameter. DEMONSTRATION.

All-Glass Schmidt Projection System†. Apparatus is shown for producing an enlarged image of the trace seen on the face of a cathode-ray tube (such as might be used in navigational radar). The tube in this set-up is only 2½ in. in diameter. The light-retaining properties of the system are good, and permit its use in any not too brightly lit area. The enlarged image is quite flat, and well suited for analysis with transparent scales etc. The aspheric lens has been made by a new process, which is a combination of glass shaping and glass grinding and polishing techniques. DEMONSTRATION.

Optical Elements†. A wide range of prisms, lenses and various other optical elements, made in glass, quartz, fused quartz, etc. is shown. Optically worked plane galvanometer mirrors only 0·005 in. thick are of special interest.

Stand 33

THE PRECISION TOOL & INSTRUMENT CO., Ltd.,

353, Bensham Lane, Thornton Heath, Surrey

Triangular Optical Bench†. Recently designed fittings are shown for use with a triangular optical bench. They include : special lamps, double stem saddles, bench stops, swing-over saddles and adjustable saddles.

Optical Bench Number Two†. This kinematic bench has been recently re-designed to improve the rigidity. The opportunity has been taken to remodel the saddles and the scale and vernier reading has been arranged so that it is easier to read than before. The Rack and Pinion type of vertical adjusting saddle has been superseded by a coarse screw form of adjustment which is self-sustaining even with the heaviest of optical fittings.

OPTICAL COMPENSATORS†. In 1949 we were able to exhibit unfinished prototypes of the Babinet and Soleil Compensator. This year we are able to show production models.

Babinet Compensators†. This compensator consists essentially of two quartz wedges of equal angle, placed so as to form a plane parallel plate. The

optic axis in the wedges are at right angles. One wedge is movable by a micrometer screw to which is fitted a graduated drum. The complete compensator may be rotated about an axis perpendicular to the basal planes of the wedges, and its angular position read to 0·1° by readings on a circle and vernier. The compensator is fitted with an analyser, the angular position of which may be read from a circle divided to 2°. Calibration shows that one drum division for $\lambda = 5461$ A. corresponds to a phase difference of $7{\cdot}3 \times 10^{-3} \times 2\pi$; the range is approximately $\pm 4 \times 2\pi$.

Soleil Compensator†. For measurements of very small phase difference the Soleil compensator fitted with a half shadow device is recommended. The compensator itself consists essentially of two quartz wedges of equal angle whose optic axes are parallel and which together form a plane parallel plate. One wedge is movable by a micrometer screw to which is attached a graduated drum. These two wedges are combined with a plane parallel plate of quartz whose optic axis is at right angles to the optic axis of the wedges. The half shadow device is a thin mica plate covering only half the field of view. Movement of the wedge enables the thickness of the composite plate to be varied and adjustments are made to obtain a uniform field of view. The whole instrument can be rotated about an axis perpendicular to the basal planes of the wedges and its angular position may be found by reference to a circle and vernier reading to 0·1°. The angular positions of the analyser and half shadow device can each be measured to 5°. As a general guide to use, for $\lambda = 5461$ A., one drum division corresponds to a phase difference of $3 \times 10^{-4} \times 2\pi$; the range is approximately $\pm 2 \times 2\pi$.

References from which further information on the Babinet and Soleil Compensators may be found are :

Jerrard, H. G., *J. Opt. Soc. Amer.*, 1948, **38**, 35; Jerrard, H. G., recent papers in *J. Sci. Instrum.*; Richartz, M., and Hsu, H. Y., *J. Opt. Soc. Amer.*, 1949, **39**, 136.

We are indebted to Mr. H. G. Jerrard and Professor A. M. Taylor of University College, Southampton, for assistance with the research and development of the Babinet and Soleil Compensators.

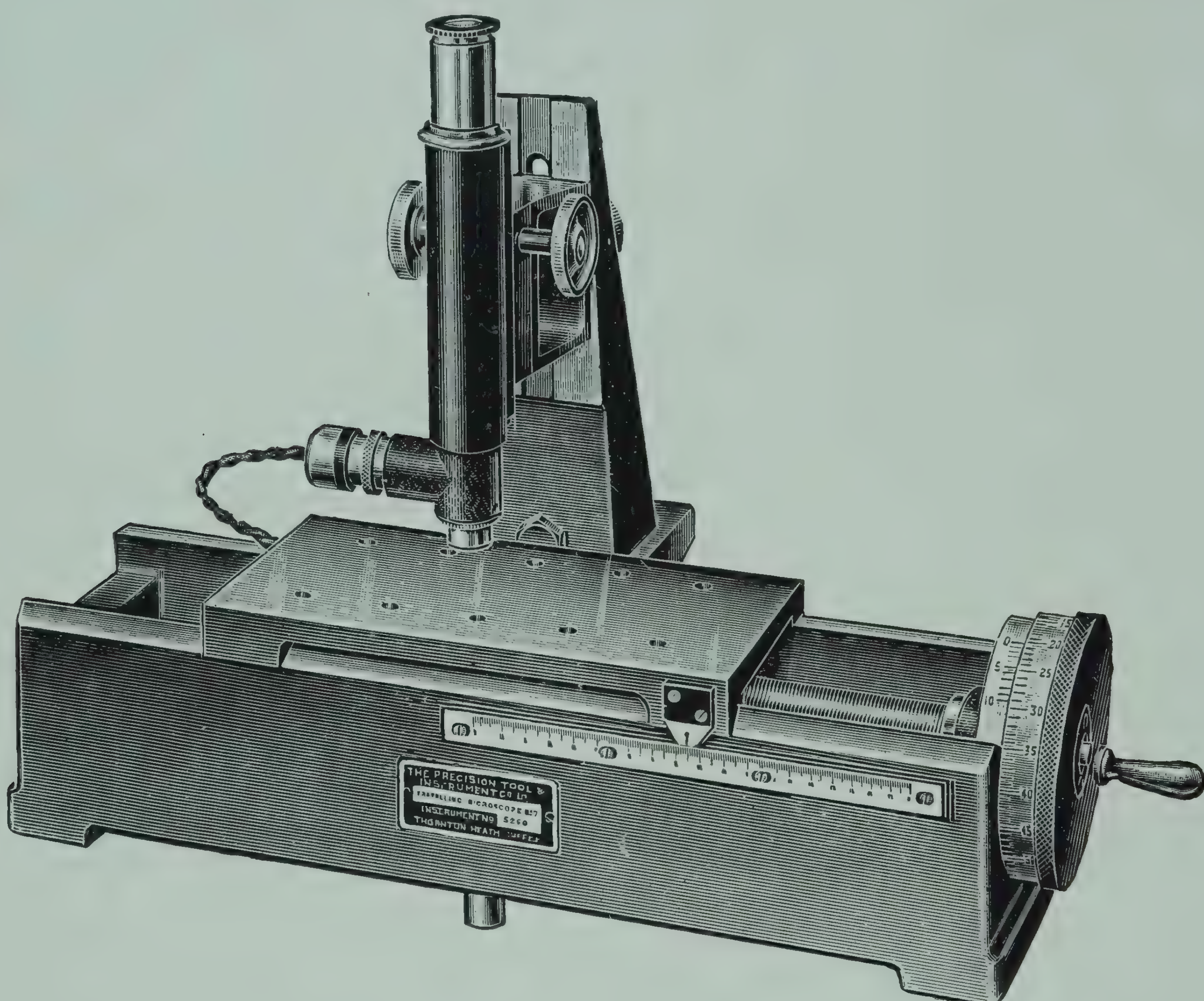
Laboratory Lamps for use as Monochromatic Sources†. At the time of compiling these notes we are developing a series of monochromatic sources for general scientific purposes. We hope to exhibit as many of these as are available should space permit.

Reading Telescope No. 1†. A reading telescope mounted on a fully universal joint which in turn is mounted on a pillar fitted to a tripod base. The telescope is arranged with a auxiliary lens which enables the telescope to be focused to any point between 16 in. from the telescope and infinity. The focusing is by means of a rack and pinion.

7½ in. Spectrometer. A spectrometer suitable for most research work. The 7½ in. diameter circle is fixed and the movements of the telescope and table may be observed by means of double-ended verniers graduated to read to 30 seconds of arc. The telescope and table each have fine adjustment screws for rotation. The telescope and collimator are 10 in. focus, 1 in. clear aperture. Each is provided with rack and pinion focusing. The slit fitted to the collimator is fitted with a wedge to adjust the length and an adjustment so that the jaws may be set mutually parallel. The slit is protected by a metal cover. A comparison prism is supplied, mounted on a swing-out platform.

Vernier Microscope Number 10†. The instrument is essentially designed for student use. The travel is 10 cm. Measurements are made by a vernier reading to 0·1 mm. The microscope is provided with slow motion focusing. The carriage may be moved by hand to the approximate position required and a fine adjustment screw is provided for final setting.

Vernier Microscope Number 13†. A measuring microscope capable of measuring coordinates in a vertical plane over an area 16·5 cm. × 12 cm. The readings are made by verniers graduated to read to 0·01 mm. The microscope is fitted with slow-motion focusing.



Measuring Microscope Number 15.

Measuring Microscope Number 15† (See Figure). A linear measuring microscope with a travel of 180 mm. The movement is controlled by a hardened and ground micrometer screw with a pitch of 1 mm. The readings are taken from a micrometer vernier which reads to and gives an accuracy to 0·001 mm. The nut is fitted with a corrector bar. The microscope is fitted with a Ramsden eyepiece, glass crossline graticule, vertical illuminator and 1 in. focus objective.

Stand 34

WRAY (OPTICAL WORKS) Ltd.,

Ashgrove Road, Bromley, Kent

The following are a few of the lenses designed since the last exhibition.

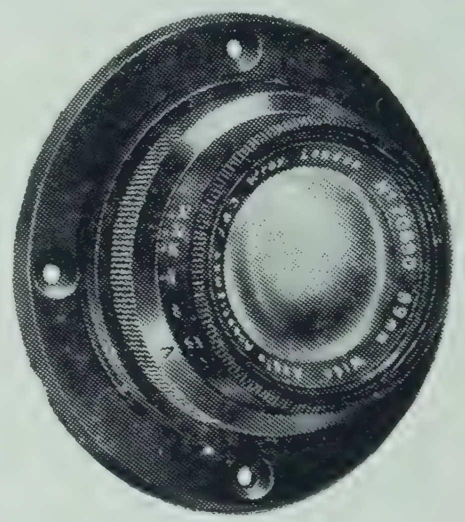
30 in. f/16 Apochromatic Process Lens†. For the longer focal length Process Lenses secondary spectrum effects become increasingly serious; this lens gives a correction of these errors to a higher degree than heretofore. It has an

extremely flat field and a high stability of aberration correction with change of conjugates.

10 in., 12 in. and 15 in. f/4·5 Lustrars†. These lenses extend the Lustrar series exhibited last year to longer focal lengths. The wide angle of field characteristic of this series is rarely required in the longer focal lengths which have, therefore, been designed to give the optimum correction over a field of 52°.

Miniature Camera Lenses, 50 mm. f/2, 50 mm. f/3.5, 36 mm. f/3.5†. This series of lenses has been produced during the last year to give the highest possible resolution on a 24 mm. × 36 mm. image.

89 mm. f/6·3 Wide Angle Lens† (see Figure). A lens with full focusing aperture of f/6·3 and a covering up to 100° of field at f/16. At f/11, satisfactory cover is given of an angle of 90°. It has an unusually long central separation together with increased glass diameter to avoid increased vignetting; an unusually good correction of oblique aberration has been achieved.



The Holophane Lumeter†. For a number of years the Holophane Lumeter, a portable visual photometer, was used by lighting engineers for both internal and external lighting and brightness measurements. During those years, modifications were made to the existing design in order to keep in step with developments in light sources and the need for measuring greater ranges of illumination.

The opportunity has now been taken to redesign the instrument so as to embody all these modifications, together with certain other improvements, in a compact form which complies with every requirement of the current British Standard Specification No. B.S. 230 : 1945.

Stand 35

BAIRD & TATLOCK (LONDON) Ltd., RESEARCH & DEVELOPMENT DIVISION, St. Cross Street, London E.C.1

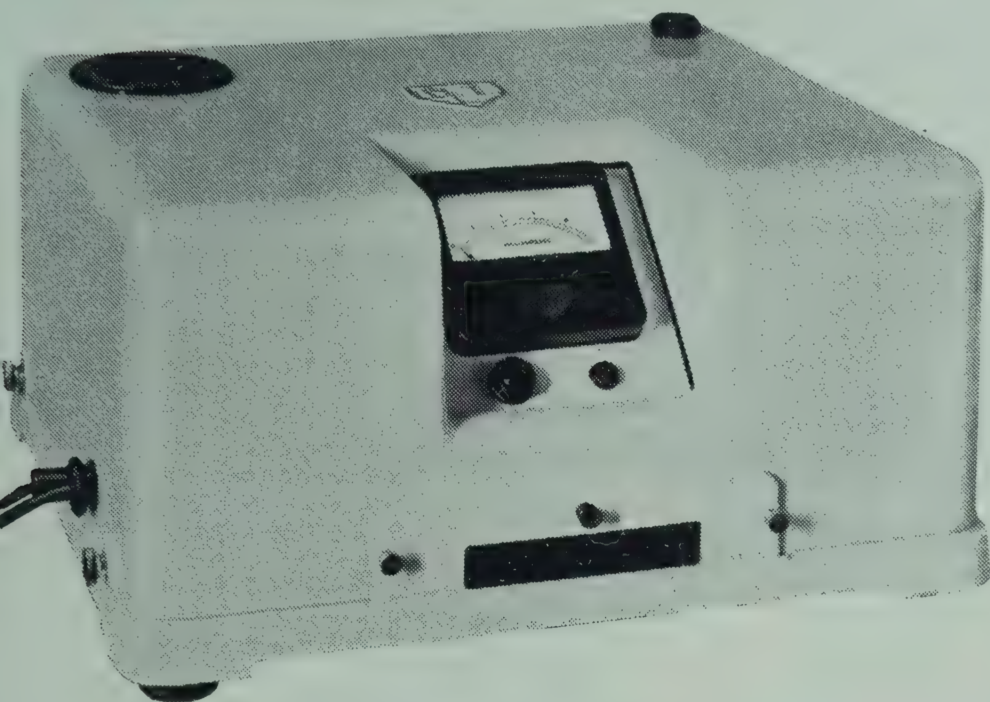
Self-Balancing Photoelectric Absorptiometer for Chemical Analysis†. This instrument was produced in collaboration with Imperial Chemical Industries Ltd., to whom the principle, fundamental design, and much of the development work are due Figure 1(a).

The requirement was for an instrument which would detect small changes in the colour of a liquor being used in a chemical process, and provide continuous quantitative indication of these changes on a recorder. With suitable colour filters the instrument may be calibrated to record the composition of any liquid whose absorption can be related to some form of chemical analysis or turbidity.

The instrument is based on the principle of automatic re-balancing using negative feedback; a functional diagram is shown in Figure 1.

Vacuum emission-type photocells are employed in adjacent arms of a bridge

measuring circuit. Light from the lamp passes through two identical 'absorption cells', containing the liquor being analysed and a standard, before reaching the photocells. Absorption of all or part of the light falling on one of the photocells causes an out-of-balance E.M.F. to appear across the bridge. This E.M.F. is amplified and applied to a mirror galvanometer placed in the light path, so that



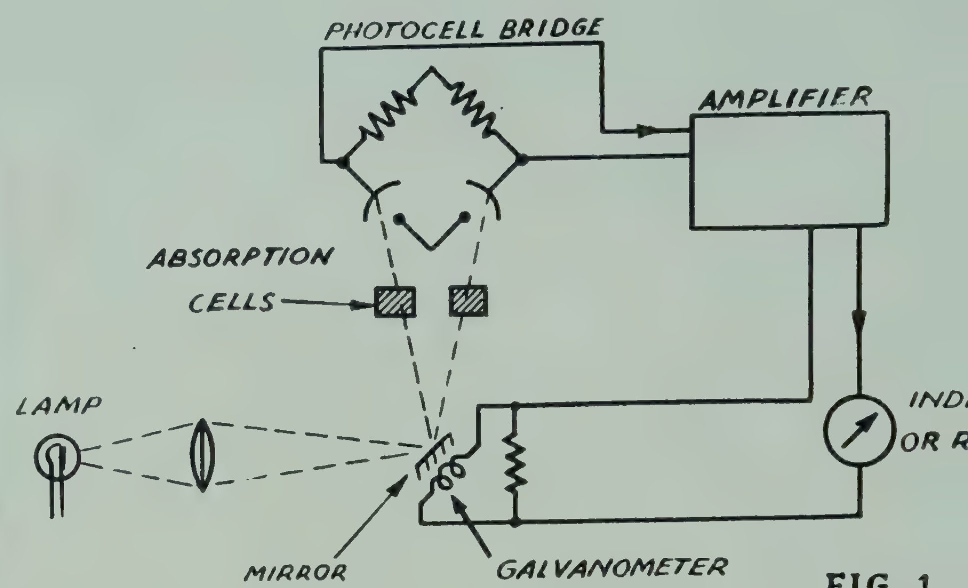


FIG. 1.

Figure 1 (a). Photoelectric Absorptiometer.

the beam moves to increase the area of illumination on the photocell affected. Thus any disturbance causing unbalance of the bridge is automatically re-balanced by movement of the galvanometer mirror, and the galvanometer current will be a function of the initial disturbance.

The time lag of the instrument as originally developed was required to be small and, since only a small quantity of the liquor (about 2 cm^3/min.) was available, the absorption cells themselves were small, and such that only 5% total light absorption could be obtained to give full-scale deflection for colour changes of the magnitude to be detected. For this reason the use of a fairly sensitive amplifier was necessary. In order to overcome the instability usually associated with sensitive electronic devices the method of automatic self-balance was employed. The arrangement is reasonably independent of variations in lamp intensity, amplifier gain and photocell characteristics. (In particular, it can be shown that insensitivity to fluctuations in the gain of the amplifier is in fact achieved by making the gain high.)

The 'continuous flow' type of absorption cell is used where it is necessary to record colour changes in a liquid being used in a continuous chemical process, a small sample being by-passed through the absorptiometer. Ordinary 'static' cells may be used for individual analyses, in which case the recorder is dispensed with, readings being taken on the calibrated milliammeter on the front panel. Caesium- or potassium-photocells ('Osram' CMV6 or KMV 6) are used, with appropriate colour filters, according to the spectral region used.

An Apparatus for Measuring and Recording Small Temperature Changes in the range 0 — 100°C. This apparatus is in the experimental stage, and has been made to investigate the possibilities of measuring and recording temperature changes of the order 0·01°C. or less, using a liquid of high coefficient of expansion, such as toluene.

The apparatus consists of a 'temperature/capacitance' converter, a pair of high-frequency valve oscillators, a detector and audio beat note amplifier, and an audio-frequency meter. The function of each of these main components is shown in Figure 1.

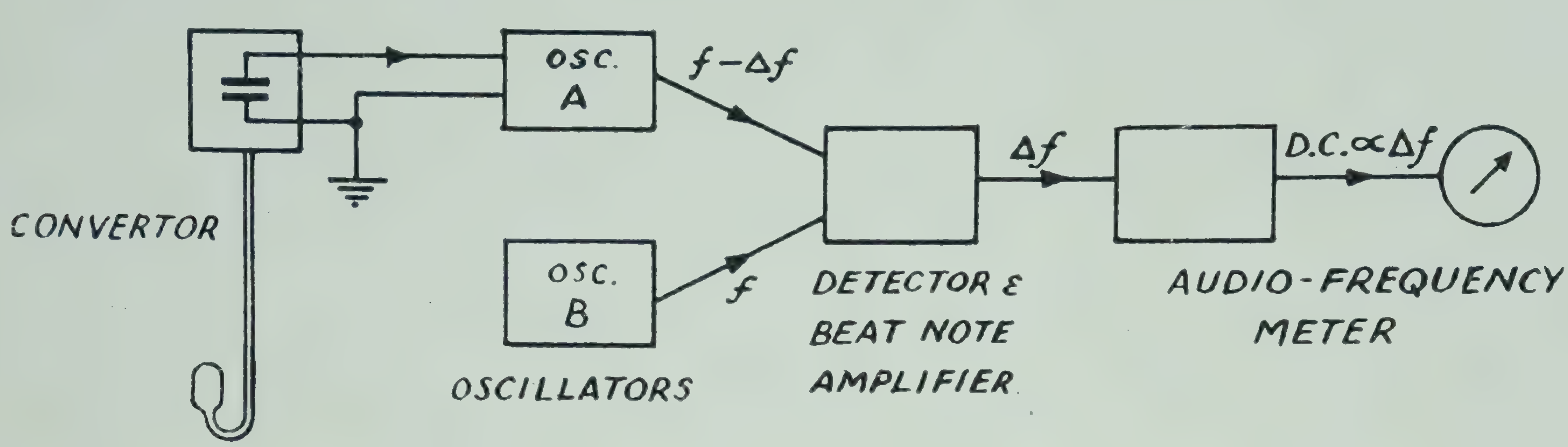


FIG. 1. *BLOCK DIAGRAM OF APPARATUS.*

Apparatus for measuring small changes of temperature.

The converter is essentially a toluene-mercury 'regulator' modified so that the movement of the mercury meniscus in the capillary causes a change in the electrical capacitance to earth of a surrounding insulated mercury jacket. This converter, which will be referred to as the 'Capacitance Thermometer', is the only specialized part of the apparatus, and is described below in greater detail. The rest of the apparatus is constructed from standard radio components.

The frequencies of the oscillators A and B are of the order of $f = 250$ kc/s., adjustable over a range of about $\pm$ 50 kc/s. by variable condensers. The capacitance thermometer is connected in parallel with the condenser of oscillator A. The arrangement is such that a change of — 0·01°c. in the bulb of the capacitance thermometer results in a change Δf of 600 c/s. at the maximum useful sensitivity. The sensitivity of the apparatus may be altered by varying the tuning condensers in the oscillators, and by altering the range of the frequency meter. The meter

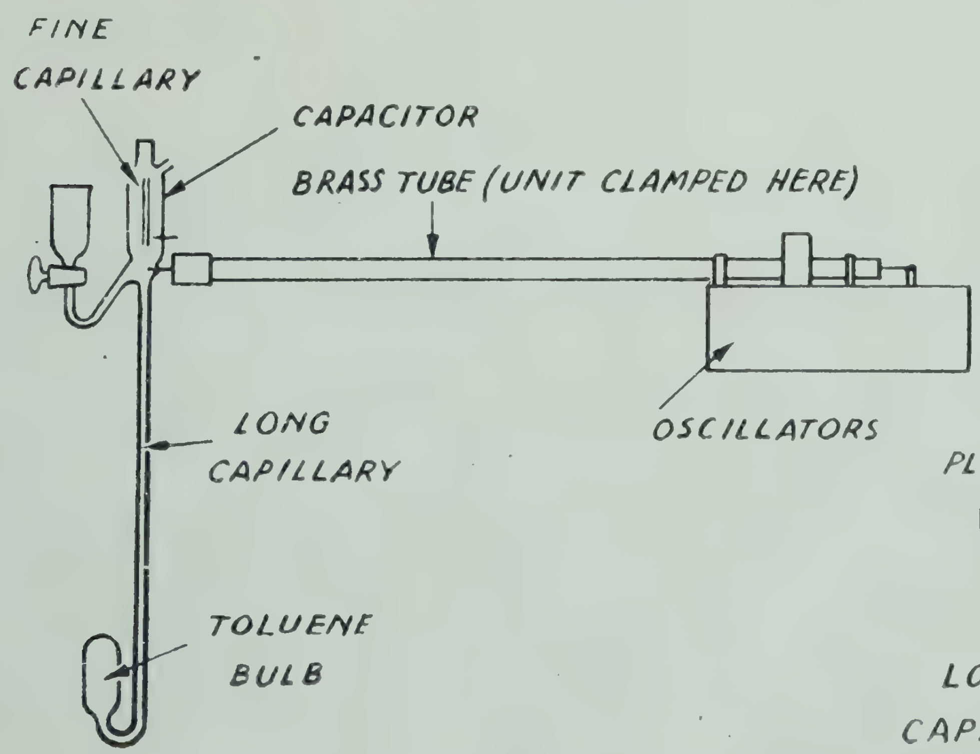


FIG. 2. *OSCILLATORS AND CAPACITANCE THERMOMETER*

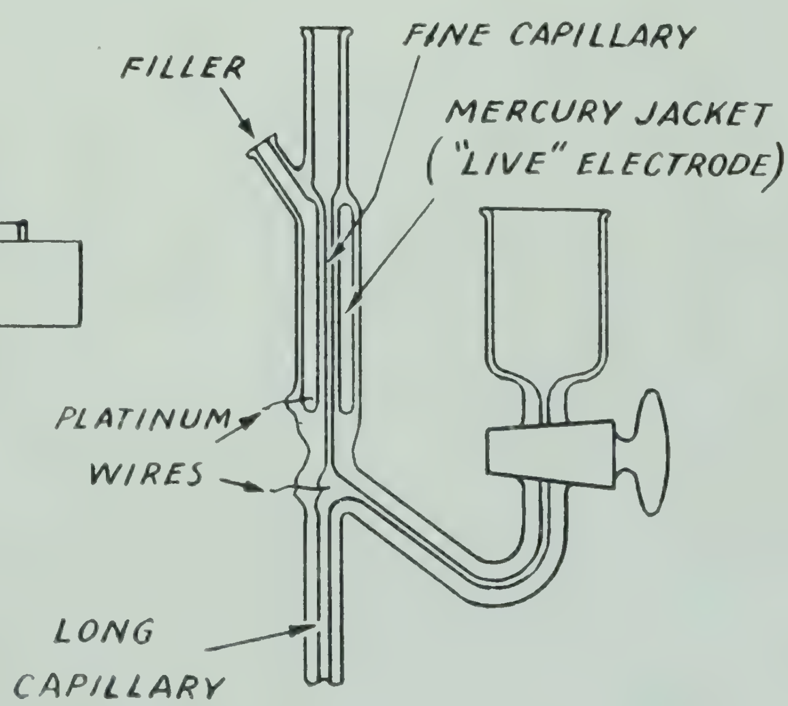


FIG. 3. *HEAD OF CAPACITANCE THERMOMETER (APPROX. 2/3 F.S.)*

Apparatus for measuring small changes of temperature.

deflection is roughly proportional to temperature variation from that corresponding to $\Delta f = 0$ in the toluene bulb. Since the oscillators synchronize when their frequencies become nearly equal the first fifth of the meter scale is not used.

The oscillators are constructed as compactly as possible without allowing undesirable coupling between them to occur. Drift due to ambient temperature variation is almost completely eliminated in this way, since both tuned circuits suffer the same temperature changes. The oscillators form one unit to which the capacitance thermometer is coupled by a brass tube carrying a length of low-capacitance cable (Figure 2). Screened leads are used to connect this unit to the detector, etc.

The present capacitance thermometer is all-glass,* the capillary forming the dielectric of the capacitor (Figure 3) having an internal diameter of about 0·75 mm. and an external diameter of about 1·5 mm. This is connected to the bulb by a long thick-walled capillary of 1 mm. internal diameter.

The performance of the apparatus in the form described above may be summarized as follows :

Temperature changes of 0·01°c. can be recorded as changes of 0·2 ma. in the reading on a 1 ma. F.S.D. milliammeter. (A Beckmann thermometer is used for calibration). The greater the sensitivity of the circuit to capacitance changes, the greater is the tendency for drift of the oscillators to cause a shift in the zero, so that re-checking at regular intervals is required. Another limitation at present is the relatively large time lag (about 1½ minutes) in the response of the toluene bulb to temperature changes of the above order.

The apparatus can be used with a recording instrument, or its output can be adapted for control purposes. It has the advantages of simplicity and ease of adjustment over the range 0 to 100°c.

Measurement of Soil Moisture under Field Conditions by the Electrical Resistance Method†. A method of obtaining a continuous measurement of soil moisture over the range critical to plant growth is a necessary technique in plant science studies. Film energy relationships have been employed in making indirect determinations of soil moisture but these have proved unsatisfactory in that they function only through the upper range of capillary water and the lower limits of saturation.

In 1940 Bouyoucos and Mick (*Mich. Exp. Sta. Tech. Bull.* 172) published a method by which continuous measurement of soil moisture values could be obtained using a direct electrical resistance method. A porous block of plaster of Paris is buried in the soil. Continuous films of water are established between the block and soil, and by the operation of surface tension the moisture content of the block follows that of the soil. There is a consistent relationship between these moisture contents on the drying curve, but hysteresis effects intervene while the soil is being wetted. This method is therefore appropriate to the study of drought and of moisture use by crops. A pair of electrodes is cast into the block and the resistance between them is governed by the moisture content of the block. Insulated leads carried to the soil surface permit continuous recording without the labour and disruption caused by soil sampling.

Bouyoucos and Mick describe a flat rectangular block having a cross section

*Further development will include investigations with metal bulbs, with a view to reducing the time lag, and a study of the causes of zero drift and their elimination.

of about 3·4 cm. × 1·2 cm. with the electrodes spaced about 2 cm. apart. This arrangement has at least two serious objections, viz.: (*a*) the block must be placed by a post-hole auger, causing considerable disruption of the structure of the subsoil, (*b*) more than half the testing current passes outside the block, through wet soil, in unstandardized conditions.

In 1942 Slater (*J. Amer. Soc. Agron.* 34) published details of a block using coaxial electrodes in which all the current must be carried by the saturated solution of calcium sulphate in the wet plaster and which thereby avoids the effects of the chemical composition of the surrounding soil.

Dr. H. C. Pereira, of the Scott Agricultural Laboratories, Kenya, has developed the Slater block and produced a cylindrical unit which has the great merit that it can be placed down a small auger hole with a minimum of soil disturbance. This is a distinct advantage in deep tropical lateritic subsoils where plant roots go down over twenty feet, and water reserves must be studied to depths of that order.

This Company is now co-operating with Dr. Pereira and producing a number of different cylindrical cells with various electrode formations. One such cell is shown in Figure 1.

Figure 1. Absorption Cell.

Figure 2. A.C. Ohmmeter.

To avoid polarization effects, A.C. must be used in making the resistance measurements of the blocks and this Company has developed a portable A.C. Ohmmeter for the purpose. Testing current is obtained from a hand driven A.C. generator built into the Ohmmeter and the instrument has been sturdily designed for routine use by unskilled field assistants. This instrument is shown in Figure 2.

The Preston Density Comparator† (Figure 1). In 1945 the Committee on Testing Procedures of the Glass Container Manufacturers Institute, New York, U.S.A., issued a bulletin on the control of tank-glass. This report dealt with the use of glass density as an aid to process control in maintaining glass quality. For some four years the Preston Laboratories conducted research, sponsored by the Testing Procedure Committee, into the question of 'cord' in glass and the result has been a better understanding of the relation between composition differences and density differences of glass.

It has been customary, for many years past, for manufacturers, at intervals,

to analyse glass in their products; sometimes in their own laboratories or in a central laboratory. In either case the analysis takes time, usually days, and it is therefore of little use for prompt control and corrective action. This difficulty has always been recognized and is inherent in the complications of analysis. Chemical analysis has, however, an even more serious disability, sometimes ignored or unnoticed, that it is often not accurate enough to serve as a means for process control. Errors in an analysis can occur that are often greater than the variations they are intended to suppress. It is a fundamental of any control that its error must be less than the process errors it is designed to control. This is not to deny that chemical analysis has its very definite uses, it must in fact be used to interpret the density changes on occasion, but process control is not one of these uses, primarily because it is too slow, and also because it may not be sufficiently accurate.

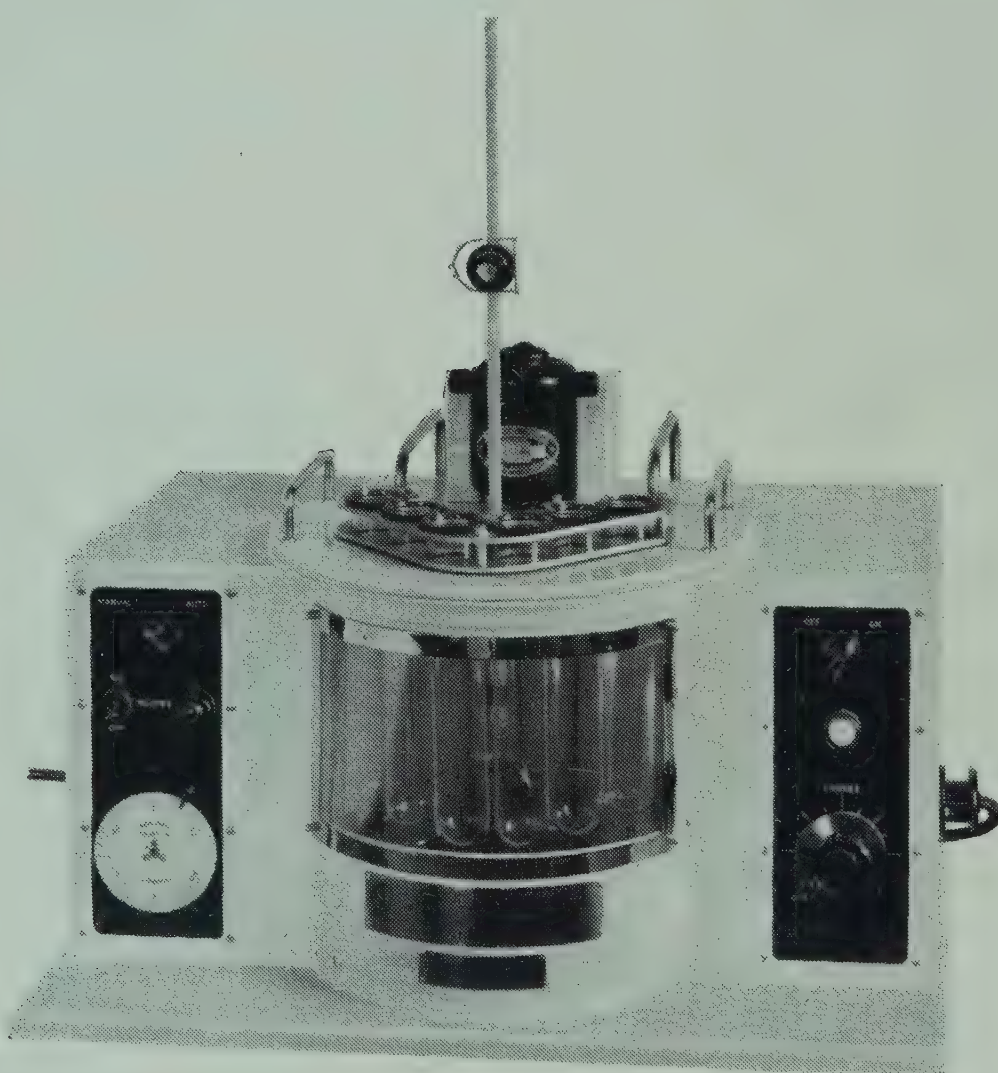


Figure 1. Preston Density Comparator.

Process control in glass manufacture is particularly important in the day-to-day control of homogeneity. The Preston Density Comparator provides a ready means for the accurate determination of glass density by the 'Sink-Float' Method in comparison with known standards. Care has to be taken in the selection of the ware which must be to an accepted standard grade of annealing. Although carefully controlled re-annealing might appear theoretically desirable, it is time consuming and costly; it is not recommended in commercial practice, since controlled selection of the samples makes it unnecessary.

The method involves the settling of lumps of glass in a mixture of heavy liquids; this is done in a water bath by means of a constant rate of heating of the liquid. The temperatures are read at which the unknown and the known lumps pass a reference level in a tube of heavy liquid. The densities of the unknowns are

then determined, from that of the known, by means of predetermined coefficients for the changes of density with temperature for the liquids.

Limits for the permissible density variation in any glass can be determined and corrective action taken when these limits are exceeded. The apparatus gives information as to density variation and the immediate interpretation for corrective action, prior to an analysis, is a matter of experience.

As a result of experiment the method of steady heating is used (as against steady cooling) and by means of adjustments in the apparatus the prime requisite of a reproducible heating schedule is maintained. The precision of control and

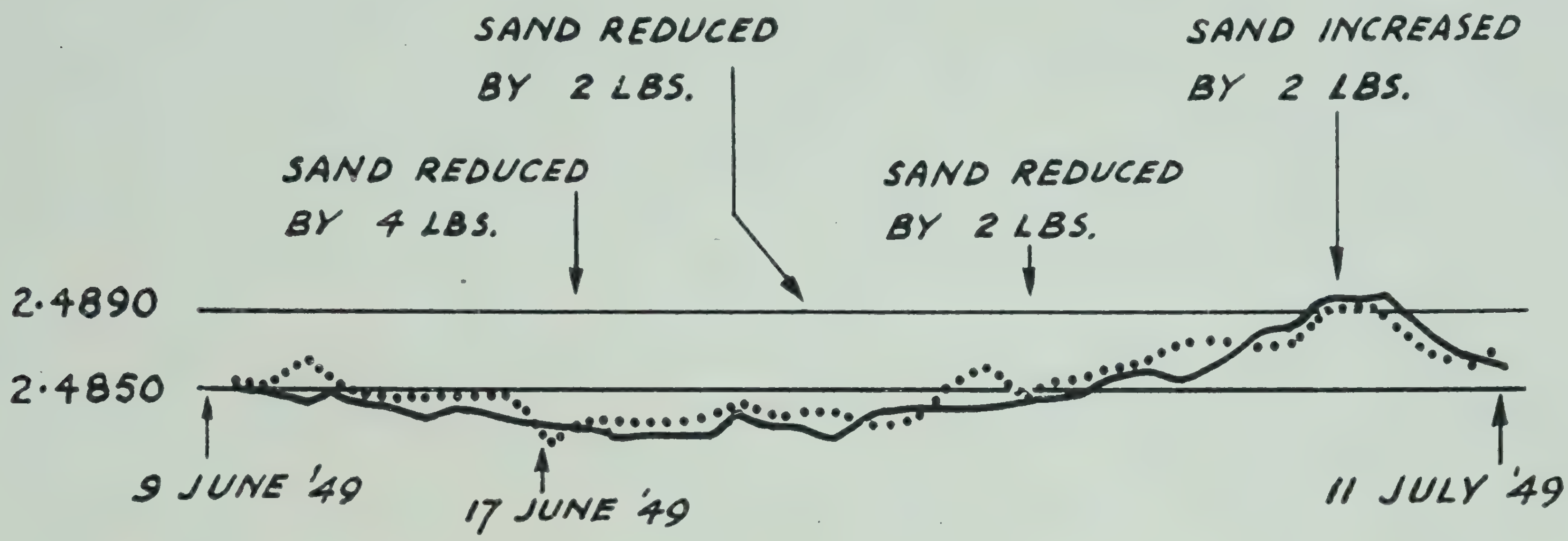


CHART FIG. 2.

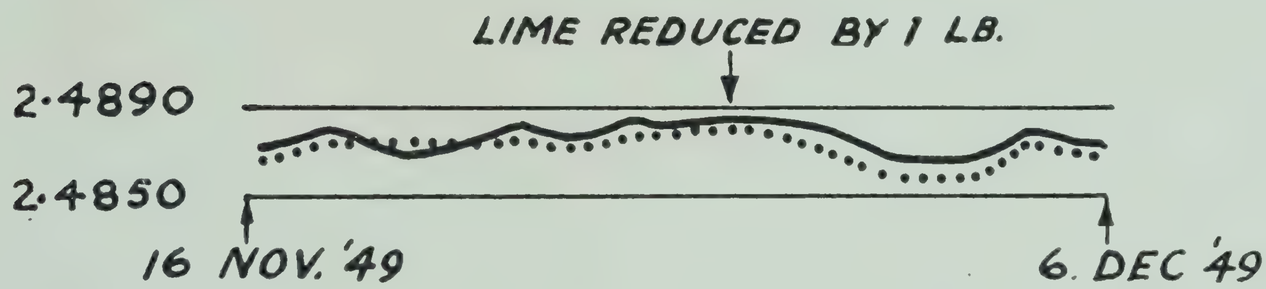


CHART FIG. 3.

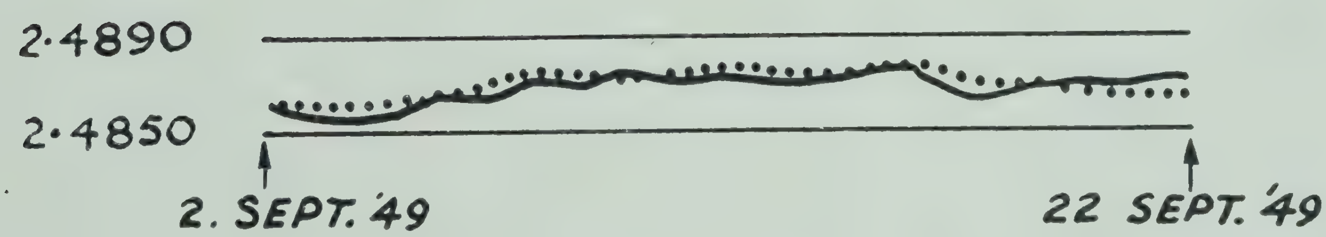


CHART FIG. 4.

THESE CHARTS ARE PUBLISHED BY COURTESY OF
DR. E.J. GOODING.
MESSRS: THE ROCKWARE GLASS SYNDICATE LTD.

Figures 2, 3 & 4 of Preston Density Comparator.

ease of operation are greatly enhanced by a time-clock regulator to control the on-off periods for the heater; the power output is such that the bath can be uniformly heated at about 0·1°C. per minute over the operating range.

The organic liquids used in the heavy liquids mixture are a-bromonaphthalene and s-tetrebromoethane. The precision of the method (reproducibility) with careful work is of the order of 0·0002 gm/cm^3 for successive determinations. The spread in density between various lumps from the same piece of ware indicate the degree of homogeneity of the glass in question.

The apparatus which this Company has produced with the co-operation of the British Hartford-Fairmont Syndicate Ltd. for carrying out the technique described above is shown in Figure 1. The water bath is a glass vessel mounted in a metal cabinet; to the water bath cover a motor driven stirrer and heating and cooling coils are fitted, while on panels at the side of the bath are mounted the time switch and other control gear. Monel metal is used almost exclusively in the construction of this apparatus and the general finish is in cream stoved chemical resistant enamel.

To illustrate the use of Density records in practice three charts are shown as follows:

Figure 2 shows a density change due to sand delivery from a different supplier. Chemical analysis showed a higher silica content and three reductions in sand weight were made: this took the density above control limit and a weight increase brought the glass back on to correct density.

Figure 3. Analysis showed the soda content as correct. The lime was therefore reduced. On subsequent investigation it was found that the lime barrow, shot-weighted to a correct weight, had been damaged and the shot had leaked out giving too much lime.

Figure 4. A record on a furnace over a period when no analysis was taken since the density record showed no undue deviation.

All charts are on a clear glass furnace. Figures 2 and 3 are on the same furnace. Figure 4 is on a different furnace. Records shown are from two stations on the furnace.

This apparatus is sold by The British Hartford-Fairmont Syndicate Limited, of Rockware Avenue, Greenford, Middlesex, to whom all enquiries and orders should be addressed. Figures 2, 3 and 4 are published by the courtesy of Dr. E. J. Gooding of the Rockware Glass Syndicate Limited.

Stand 36

Messrs. NASH & THOMPSON Ltd.,
Oakcroft Road, Tolworth, Surrey

Multipoint Rapid Temperature Recorder†. This instrument is designed to record the temperature indications of as many as twenty thermocouples when these temperatures are changing rapidly.

The set of couples is ' scanned ' in six seconds so that the thermo-E.M.F. from each in turn is fed to a ' chopper ' type D.C. amplifier. The amplified voltages are photographically recorded on a cathode-ray oscillograph. Provision is made for the simultaneous recording of standardizing E.M.F.'s.

In order to conserve film when long runs with less rapid temperature changes have to be recorded, provision is made for recording only every nth scan where n is selected by switch from a range of values.

For visual work another type of display may be selected, in which the traces of any one scan are spread across the screen.

Colour Comparator†. This apparatus is suitable for comparing the colour of slightly differing specimens of similar materials, if they can be presented in the form of flat surfaces not smaller than 1½ in. square.

Two beams of light from a single source are interrupted in opposite phases by a rotating shutter. The two surfaces to be compared (one, if desired, may be standard white) are illuminated by the two beams. Light reflected at 45° from each surface falls on to a barrier-layer photocell, which thus ' sees ' each surface alternately. If the surfaces are not identical there is a flicker in the illumination of the cell which appears in its output as an A.C. component. This A.C. component is amplified and shown on a meter. The meter reading is then a direct measure of the difference in brightness of the two surfaces. Suitable meter ranges are provided and provision is made for inserting colour filters in the light beam.

The apparatus is at least as sensitive as the human eye and has the merit of ascribing numerical values to slight differences.

Photoelectric Controller. In the application demonstrated a modified Ascot-Casella micromanometer is used with this apparatus to control the pressure inside a container to which air is supplied from a fan and from which air is extracted at a variable rate.

The micromanometer is fitted with a barrier-layer photocell and a small electric light: between the two moves a vane attached to the beam of the manometer. The output from the cell, after amplification, controls the speed and rotational sense of a split field motor, which in turn, through reduction gears, rotates the spindle of an autotransformer. The output from this transformer is the supply to the motor of the fan which provides air for the container.

The apparatus will control the pressure inside the container to within 10^{-4} in. W.G. and its rate of drift is less than 10^{-4} in. W.G. per hour. It compensates for a very abrupt change in the rate of withdrawal of air in about a minute, and for small step change without appreciable lag.

The basic part of this apparatus should have a wide applicability to a variety of control problems. It only requires that the out-of-balance signal should be fed to it as a small electrical signal and that the restoring mechanism may be actuated by the rotation of the split field motor, either directly or through a subsidiary link such as the auto-transformer described above. Valves, heaters, motors, etc., may be controlled by photocells, thermocouples, strain gauges and a variety of other detectors.

Flowmeter†. This instrument is for the measurement of low gas flows in pipes. The principle is to supply heat to the gas at constant rate and to measure the consequent rise in temperature differentially by a pair of platinum grids. The heating element and the grids are spaced evenly over the cross section of the tube so that traversing is not necessary.

Two models have been developed, one direct reading, the other a null instrument. The former is accurate to within 2% and the latter, which is especially useful for the measurement of small variations in large normal flows, to within 0·2%.

The flowmeters are made in two standard sizes, 3 inches diameter and 5 inches diameter, and are about 5 inches long. Other dimensions can be made to order.

Stand 37
ADVANCE COMPONENTS Ltd.,
Back Road, Shernhall Street, Walthamstow, London, E.17

Signal Generator Type E.2†. A reliable instrument giving a frequency range of 100 kc/s. to 100 Mc/s., accuracy to within $\pm$ 1%, internally modulated 400 c/s. 30%. Leakage less than 3 microvolts. Output is 1 μv. – 100 mv. into 75 ohms or 1 v. at high impedance. A termination pad is provided giving 37 ohms, 10 ohms or dummy aerial output.

Signal Generator Type B.4†. This laboratory instrument is manufactured in two models giving frequency ranges of 30 kc/s. – 30 Mc/s. or 100 kc/s. – 70 Mc/s. Modulation is : internal, 0-50%, 400 c/s. ; external, 0-80%, 100 c/s. to – 10,000 c/s. Output volts and percentage modulation are monitored. By use of a calibrated crystal voltmeter followed by a very accurate attenuator accuracy of output level is to within $\pm$ 1 db. The instrument is directly calibrated and has an accuracy to within $\pm$ 1% in frequency. An additional vernier scale is also provided to enable the user to reset the instrument to a close accuracy. Leakage and stray radiation is less than 1 microvolt. Output is 1 μv. – 100 mv. into 75 ohms. A termination pad gives 37 ohms, 10 ohms or dummy aerial output.

V.H.F. Signal Generator Type D.1†. The D.1 covers the frequency range of 10 Mc/s. to 310 Mc/s. on 6 bands. It is chart calibrated, and accurate to within $\pm$ 1%. Internal modulation is available at 1000 c/s. 30% and 1000 c/s. 50/50 square wave. The input to an inductive slide wire is set using the internal voltmeter, and output to 75 ohms load is indicated by the reading of the slide wire and the resistive attenuator. Accuracy of output level is to within $\pm$ 2 db., $\pm$ 1μv. from 10 Mc/s. to – 150 Mc/s., and to within $\pm$ 2 db., $\pm$ 2 μv. from 150 Mc/s. to 310 Mc/s.

Audio Generator Type F.1†. This is a beat-frequency oscillator covering the frequency range 100 c/s. to 10,000 c/s. in one range. Three output impedances are obtainable, viz., 600 ohms, 5 ohms and 10 ohms attenuator. Output which is monitored by a rectifier moving-coil meter is one watt at 600 ohms or 5 ohms, and a maximum of 2 volts is obtainable from the 10 ohms attenuator which has three 20 db. steps. Distortion is less than 3% at 1000 c/s. with 1 watt output.

Audio Generator Type H.1†. This instrument covers the frequency range of 15 c/s. to 50,000 c/s. in three ranges. It incorporates a bridge type resistance – capacity oscillator followed by amplification with heavy negative feedback. Distortion is low, viz., less than 1% at 1000 c/s. A useful feature is the incorporation of an optional square-wave output. Output is from continuously variable and step potentiometers being 200 microvolts to 20 volts sine wave, or 400 microvolts to 40 volts square wave.

Attenuator Type A. 38†. This attenuator is designed to give accurate attenuation up to about 300 Mc/s. It is normally fitted with a 75 ohm unbalanced

ladder network of four 20 db. steps. High stability carbon resistors are used and accuracy is to within ± 0·2 db. per step at low frequencies ; the attenuation rises to about 20·5 db. per step at 300 Mc/s. The attenuator consists of a die casting housing the resistor network and switching mechanism. The contacts are rhodium tipped and are arranged to lift as the switch is rotated.

Constant Voltage Transformers†. These transformers operate on a saturated core principle. They are available in sizes from 4 watts to 2 kw. The efficiency is 80 – 90% at full load except in the very small sizes. The units will operate at all loads from zero to full load. Output variation is ± 1% for ± 15% change in input volts.

Constant Voltage Unit Type T.U.7A†. Primarily designed to give a constant 12 v. D.C. supply for pH meters. It consists of a constant voltage transformer followed by a bridge rectifier and inductance capacity filtering. Its light weight, low consumption and stable voltage offer considerable advantage over the cumbersome accumulator which it replaces. It operates from a 230 v. 50 c/s. supply giving 12 v. D.C. at 100 ma.

Stand 38
FURZEHILL LABORATORIES Ltd.,
Boreham Wood, Herts

Cathode-Ray Oscilloscope, Type 1684D/2†. This is a general purpose instrument having a high and uniform level of D.C. amplification, with two discrete (optional) conditions of sensitivity, viz.:

(*a*) 7 mv. r.m.s. cm. from zero frequency to 1·2 Mc/s.

(*b*) 21 mv. r.m.s./cm. from zero frequency to 3 Mc/s.

Direct-coupled circuiting is used throughout and among the advantages arising from this system are the instantaneous positioning of the image due to the D.C. shifts, and a remarkable stability of operation due to the symmetrical circuiting which also provides discrimination against unwanted signals, and results in complete functional independence of the various controls.

The time-base, which may be operated either recurrently or single-sweep, is variable from 2 c/s. to 150 kc/s. but the lower limit may be reduced to 0·2 c/s. by the addition of external condensers. The time-base output is fed to the tube through the X amplifier, thus permitting the X gain control to expand the trace 10 times.

Synchronization is automatic in operation while a voltage-limiting circuit prevents over-synchronization.

Cathode-Ray Oscilloscope, Type 1684N†. This instrument has been designed for low- and audio-frequency work and has a very high sensitivity of 1 mv. r.m.s./cm. over the range of zero frequency to 50 kc/s. An input attenuator with a range of 10,000:1 permits signals up to 80 v. to be handled.

Direct-coupled circuits are used throughout, providing most of the desirable features of the 1684D/2. The time-base is variable from 5 c/s. to 10 kc/s. and may be operated either recurrently or single-sweep. The lower frequency limit of the time-base may be extended by addition of external condensers. The time-base is fed to the tube through an X amplifier permitting the sweep to be expanded 10 times ; the X amplifier performance, however, is limited to that necessary to perform this function.

Oscilloscope Camera, Type 1684J/2†. This has been specially designed for use with the 1684 series of Oscilloscopes. A maximum writing speed of about 3 km/sec. referred to the tube face, can be obtained with the f/1·9 lens.

Daylight-loading cassettes for perforated or plain 35 mm. film or paper are used, the maximum loading being about 4 ft., corresponding to 36 exposures of 25 mm. × 25 mm.

Beat Frequency Oscillator, Type AF.200B†. This is a heterodyne audio-frequency oscillator providing an output of up to 2 watts into resistive loads of 60 ohms or 10 ohms over the frequency range of 50 c/s. to 20 kc/s. The scale arc is 270°, calibrated approximately logarithmically up to 1 kc/s. and linear thereafter to 10 kc/s., while the range is extended to 20 kc/s. by an additional switch.

The output is indicated by a rectifier voltmeter. The frequency drift after the first half hour of operation does not normally exceed 10 c/s. during the course of an average day. The hum and R.F. content are extremely low whilst the harmonic content is less than 3% over most of the frequency range.

Sensitive Valve Voltmeter, Type 378B/2†. This is an improved version of the Type 378B, having a high input impedance on all ranges and reading from 1 mv. to 100 v. over the frequency range of 10 c/s. to 500 kc/s.

The instrument comprises a cathode-follower input stage, followed by an R-C coupled amplifier incorporating a feedback loop in which is a germanium diode bridge network. Across this diode bridge is an indicating meter calibrated in terms of r.m.s. voltage applied to the input. A logarithmic scale shape provides a linear decibel scale and a constant reading accuracy over the entire range. The meter cannot be damaged by accidental overloads. The instrument may also be used as a voltage amplifier having a gain of about 10,000 over a very wide frequency range.

The voltmeter is stabilized by negative feedback and other means against secular and mains variations.

Stand 39

C. BAKER of HOLBORN Ltd.,

244, High Holborn, London, W.C.1

Factory : Metron Works, Purley Way, Croydon

Apparatus for Phase Contrast Microscopy†. The outfit as exhibited consists of 2/3 in (× 10) and 1/6 in. (× 40) objectives fitted with phase plates, an Abbe Condenser fitted with a centring phase diaphragm and a microscope eyepiece fitted with 3 in. objective for centring purposes. A 1/12 in. (× 100) objective is available if required.

The outfit as exhibited varies from usually accepted practice in that a cruciform system is employed in place of an annulus, which has the advantage that one substage diaphragm will serve for all objectives and that phase plates are easier and less expensive to produce.

No alteration to the microscope is necessary and the special condenser will fit any instrument with a r.m.s. Standard Focusing Substage. DEMONSTRATION.

Low Power Binocular Microscope†. This model is of Greenough Type with the objective contained in a Triple Turret Nosepiece. The Stage, which is of circular pattern carries a self-contained illuminant and the stand is inclinable

with the Stage or independently.

DEMONSTRATION.

Students Microscope 3 E.U.†. This instrument embodies the stand supplied with all Baker Series 3 Microscopes, with the exception that the usual type of Rack and Pinion Substage has been replaced by a simple focusing mount operated by a lever, the mount being carried in a tube which is pre-centred on the underside of a plain stage.

DEMONSTRATION.

Metron Mechanical Stage†. A rigidly constructed mechanical stage fixing by one screw only, with 60 mm. of horizontal and 25 mm. vertical movement. The sliding specimen clips are adjustable and verniers are provided to both horizontal and vertical movements. DEMONSTRATION.

Stand 40

W. WATSON & SONS Ltd.,

313, High Holborn, London, W.C.1

Phase Contrast†. An accessory set with built-in light source, interchangeable phase rings for 16 mm., 4 mm. and 2 mm. objectives, interchangeable annuli for research with optimum proportions of annulus diameter and width for different objects. There is also provision for an external light source of high intensity for photomicrographic and cine work, interchangeable with the built-in source.

'Bactil' Binocular Microscopes† (see Figure) of a new design with and without inclined eyepieces, with interchangeable monocular bodies, and fitted with new type of research substage.

Microscope Objectives, Eyepieces and Condensers†, of a new design

including the 16 m 0·30 m., N.A. objective and a 3·6 mm. Fluorite objective and compensating eyepiece.

Konimeter†, with condensing attachment and built-in illumination to provide dark field and polarized light for observation of dust particles, quartz dust, etc.

It is hoped also to show new types of 'GREENOUGH' Microscopes, but particulars are not yet available.

Stand 41
THE THERMAL SYNDICATE Ltd.,
Wallsend, Northumberland

Vitreosil Hydrogen Discharge Lamps† (see Figure) are available in a number of patterns. The larger size lamp is suitable for general spectrographic use, and the smaller size lamp has been specially designed for use in Beckman Spectrophotometer housings. DEMONSTRATION.

Vitreosil Hydrogen Discharge Lamp.

Vitreosil Mercury Vapour Lamps†. The latest types of mercury vapour lamps, including the Houterman, grid and point source lamps are shown. DEMONSTRATION.

Vitreosil Electric Immersion Heaters (Improved pattern)†. These heaters (rating $\frac{1}{4}$, $\frac{1}{2}$ and 1 kw.) are particularly suitable for heating acid baths. DEMONSTRATION.

Vitreosil Mercury Vapour Pumps†. A complete high-vacuum system, assembled as for working, consists of a new Vitreosil single-stage (or two-stage) umbrella jet type pump and a Vitreosil M.V. fore pump operated in conjunction with an ordinary water filter-pump.

Special Vitreosil Apparatus†, including :

(*a*) Absorption cells for use in spectrophotometry (matched and unmatched).

(*b*) Transparent specimen tubes for X-ray analysis.

(*c*) Filtering and ignition crucibles in pure fused quartz and silica, and fitted with porous discs.

(*d*) Optical quality fused quartz lenses, prisms, etc.

Refractory Tubes and Ware†. Thermal mullite 525 ware and combustion tubes (open ends, closed one end or reduced end) for use up to 1,500°C. and also new mullite for use up to 1,700°C.

Thermal zircon ware is also shown.

Pure Oxide Refractories†. Alumina, magnesia, thoria, and zirconia small laboratory ware has now been developed for use at very high temperatures, i.e., above 1,500°C., and in some cases even above 2,000°C., and for special characteristic physical properties.

Stand 42

TOWNSON & MERCER Ltd

Croydon, Surrey

Refrigerated Brine Tank & Circulator System†. This is a complete unit designed for supplying cooled liquid at temperatures down to 0°c., or even lower, to any external apparatus. The Refrigerator Unit, of the compressor type, is housed in the base with a very thoroughly insulated cold tank above, which can contain brine or other liquid. This tank is connected by thermostat to the Refrigerator, and a pump and valve assembly is built into the unit so that this cooled liquid can be pumped through any apparatus it is designed to cool. Apart from this aspect the cold tank itself is of sufficient size and depth to be used for maintaining quite large objects at any required cold temperature.

Vacuum Drying Oven†. This is a new apparatus developed from our Metal Vacuum Desiccator. It uses the same lid with glass window, and the same method of sealing by a grease-free rubber ring in ' V ' groove. In the normal form there is a circular chamber in cast aluminium alloy, heated by special heater bands using exceptionally robust heater strip ; the bands themselves being clamped round the outside of the body. This body is then mounted in a rectangular aluminium case with thorough insulation, and the vacuum tap is fitted above the body on an extension piece protruding through the case, with a vacuum dial gauge built into the bottom of the case. A simmerstat is incorporated in the system with the knob on the front of the case, and this can be used for adjusting for any temperature that may be required, up to the usual 120°c. The door opens on special hinges, with a single clamping bolt that will be found much more convenient than the usual multiple swing bolts on the old types of vacuum ovens. The oven is provided with two horizontal shelves with a removable chassis, and adequate room below for any desiccants which may be required. The internal dimensions are : depth 8 in., width 10 in.

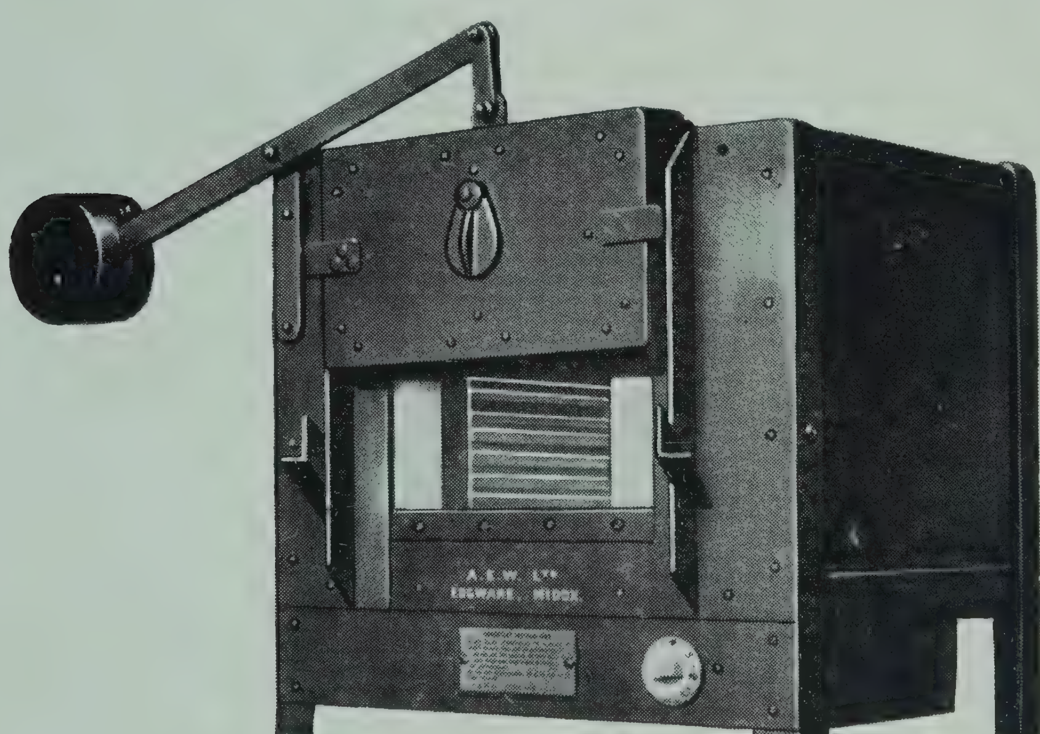
Melting Point Apparatus (Type -2-)†. The Reflected Light Melting Point Apparatus has been re-designed to make it neater, and to give less neck strain when viewing. The same principle of heated copper blocks is employed, with the light from a small bulb entering at an angle horizontally, and the sample viewed by the reflection of this light from the tubes and the contents. In this ' Type -2-' the eye-piece is set at the normal microscope angle, and the copper blocks etc. are now enclosed in a neat plated cover which makes the instrument much easier to keep clean. As before, the range runs from room temperature up to 360°c., controlled by a tapped transformer, the steps of which have been determined empirically to give suitable rates of rise. A new micro-switch controls the boost heat which cannot be left on accidentally, and is used for attaining high temperatures quickly.

Stand 43

A.E.W. Ltd.

Imperial Works, High Street, Edgware, Middlesex

Laboratory Crucible Furnaces† suitable for use with hydrogen and other atmospheres suitable for a temperature range up to 1,250°C. This furnace has been designed for laboratory use where small metal parts are to be heated in an atmosphere to reduce oxidation, such as for bright brazing etc. The chamber consists of a vertical cylinder of quartz sealed at the bottom with an outer wound low voltage element. The whole is coated with a refractory cement of high thermal conductivity, is backed with high grade heat insulating bricks and enclosed in sheet steel casing. The top of the chamber is sealed by an insulated lid with turned down edges engaging in an annular trough filled with sand. The gas enters by a small tube in the bottom of the furnace and leaves by a small tube in the lid, the pressure in the chamber being kept just above atmospheric pressure. The temperature is regulated by an energy regulator in the primary circuit of the transformer. Complete with Pyrometer and thermocouple.



A range of **Muffle Furnaces**† suitable for laboratory use and for temperatures up to 1,250°C., fitted with replaceable elements running in channels in refractory bars allowing free expansion and contraction and thus ensuring longer life. The refractory bars interlock to form the chamber and are replaceable. (See Figure).

Laboratory Ovens† suitable for temperatures up to 600°F. Made in all sizes and fitted with flame-proof elements. Forced air circulation is provided to ensure even heating throughout. Thermostatic temperature control can be supplied to any desired accuracy.

Stand 44

PERMANENT MAGNET ASSOCIATION,

301, Glossop Road, Sheffield 10

An interesting range of **Permanent Magnet Alloys** is shown, special attention being directed to the newer alloys, Alcomax III and IV, and to a most recent scientific development, the high energy Alcomax having orientated columnar crystal growth.

Sectioned magnets in this new Alcomax showing the special crystal growth will be exhibited.

A representative selection of apparatus incorporating modern permanent magnets will also be on view.

Stand 45

C. F. CASELLA & CO. Ltd.,

Regent House, Fitzroy Square, London, W.1

Stellar Spectrograph. As an essential adjunct to any large astronomical reflecting telescope, a spectrograph attached to the mirror cell is used at the Cassegrain focus and is employed for radial velocity work. This involves measuring the displacement of the spectrum, due to the Doppler effect, to an accuracy of about 0·001 mm. The problem of the stability of the plate with respect to the slit is, therefore, of the utmost importance since the spectrograph may be required to lie anywhere within a solid cone of 60° semi-angle.

Recently completed is a two prism spectrograph for use with the 74 in. reflector of the new Radcliffe Observatory, Pretoria, the first telescope of this size in the Southern Hemisphere. With this spectrograph four camera lenses of different focal lengths were provided to enable a wide range of work to be covered. The movement of the camera position to suit these focal lengths has been carried out in a novel manner which should prove to be easy in operation.

The optical parts are mounted on a rigid inner frame suspended mainly on a large self-aligning ball bearing with means of adjustment in all directions.

The method of suspension is calculated to give the desired minimum flexure to satisfy the conditions mentioned above.

This frame is in turn mounted in the jaws of a fork and completely enclosed in a temperature controlled casing. The fork is bolted via a rotatable wheel on to the mirror cell. An iron arc and different discharge tubes are provided to put comparison spectra on to the plate after the stellar exposure. A star guiding telescope focuses on the slit while a larger telescope is used for direct viewing.

The instrument was designed jointly by the staff of the Radcliffe Observatory and ourselves and forms the last item of major equipment of the Observatory. A measuring machine and a microphotometer were completed and delivered to South Africa shortly before the war.

Since the complete instrument was too bulky to be readily transported here, we have constructed a model to one-eighth scale, which demonstrates the construction, suspension, adjustment, etc. in principle.

Ascot-Casella Micromanograph†. This model, now in production, of the standard instrument is made for recording with pen and ink instead of only indicating on a scale. The principle, now well tried and used for many purposes, is as before, viz., two light bells suspended from a beam in a liquid of low surface tension which in turn is suspended on a torsion strip, thus eliminating all friction and 'stiction' effects. The scale arm carries a sector which, passing over a photo-cell, produces a current proportional to its position. This current is passed to any standard recorder and thus gives a continuous record of pressure.

This instrument is patented by Ascot Gas Water Heaters Ltd. from whom we have a licence to manufacture.

Cascade Impactor†. This is a modified version of that originally designed and used by K. R. May. The modifications consist in making each jet detachable for ease of cleaning, and alterations in the sizes of the last two jets in order to

collect particles of a slightly smaller size. The principle is, however, the same in that a series, or cascade, of jets impacts the aerosol on to 3 in. x 1 in. micro slides and automatically grades it into four size fractions. This enables a very wide range of particles both solid and liquid, stable or volatile, to be sampled with great efficiency.

According to the types of particle being studied, various different adhesives, detectors, etc. are applied to the micro slides. These are subsequently counted and sized as required under a high power, high resolution microscope.

Conifuge. This is the production model of that shown on the Department of Scientific and Industrial Research stand last year. The principle of operation is the same, i.e., centrifugal force is used to increase the terminal velocity of the particles and, by adopting a conical form, thus to deposit them progressively graded on to special glass surfaces for microscopic examination.

The principal change is that the motor is built in to the bottom of the instrument, thus making it self-contained. Other changes are minor and are merely to facilitate production.

The instrument is patented by the Ministry of Supply from whom we have a licence to manufacture.

Stand 46

R. & J. BECK, Ltd.,

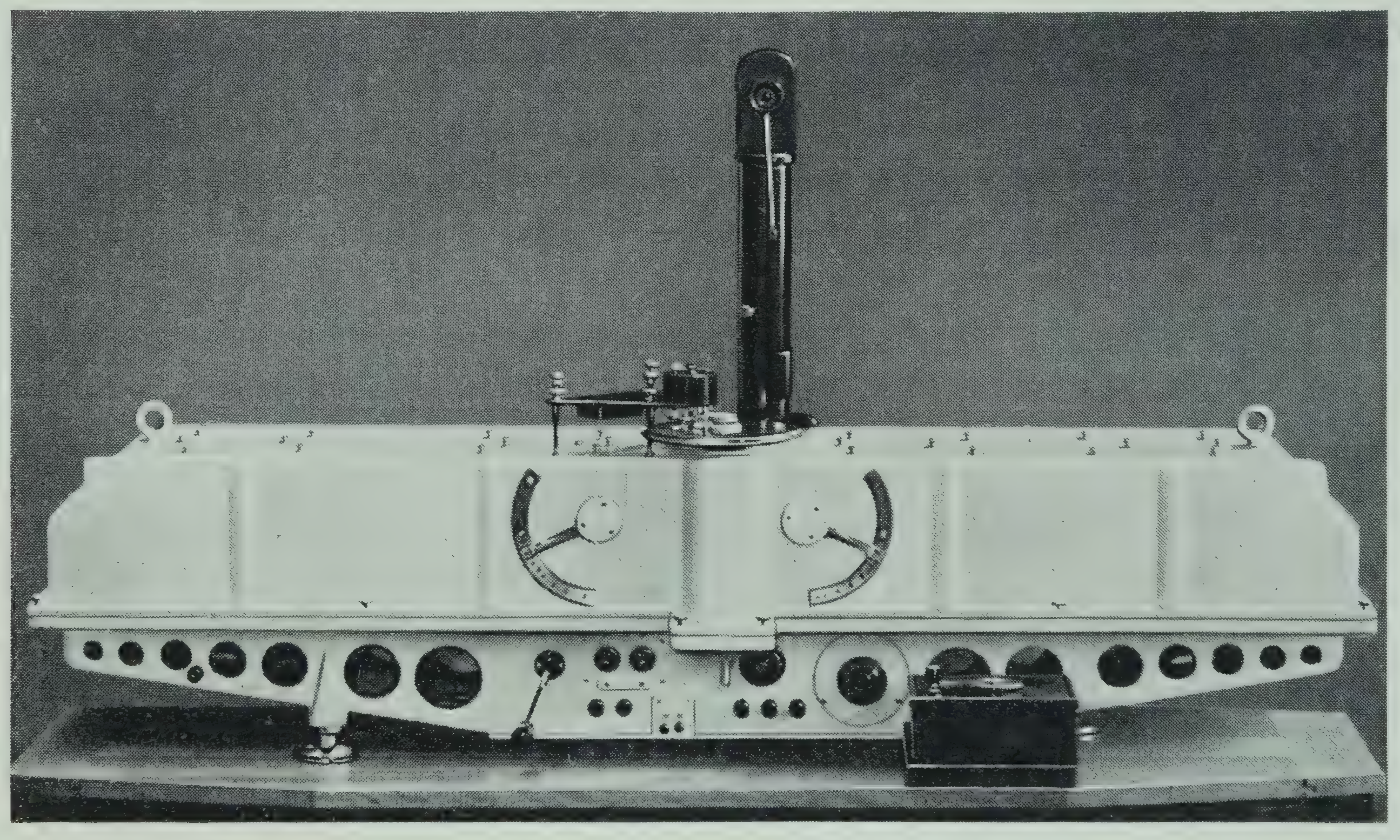
69, Mortimer Street, London, W.1

Photoelectric Ozone Spectrophotometer† (Dr. Dobson's). The purpose of this instrument is to determine the amount of ozone in the upper atmosphere by measuring the absorption of ultra-violet radiation from the sun in passing through the atmosphere. Before 1939 a number of these photoelectric spectrophotometers were made, using sodium photoelectric cells and a high-gain valve amplifier. While good results were obtained with these instruments, they could not be used when the light was very weak since the inherent fluctuations of current, or ' noise', of the amplifier became comparable with the current to be measured. Recently, photo-multipliers have become available on a commercial scale and it is possible to obtain a very much better ' signal/noise ' ratio from these than from a photoelectric cell and valve amplifier. In the new instruments, photomultipliers have been used, with the result that very much weaker light intensities can be measured accurately. For this reason, it is now possible to use wavelengths which are more strongly absorbed by ozone and thereby to reduce the uncertainties due to varying haze and other minor troubles. The present instruments have a wavelength adjustment which allows the wavelengths employed to be varied over a range of about 150 A. Further, as a result of experience gained, it has been possible to improve the adjustment of the optical system.

Light enters a window in the top of the instrument and after reflection in a right-angled prism falls on the slit of a monochromator. The required wavelengths are isolated by means of slits in the focal plane.

The measurements taken consist of measuring the ratio of the intensities of radiation passing through the slits. As the intensity at the wavelengths used is

very small compared with other parts of the spectrum, a second monochromator exactly similar to the first is arranged on the opposite side of the central focal plane. This system disperses any scattered light which may have passed the slits and brings both rays of the required wavelength to a focus on to another slit behind which is placed the photo-multiplier. A rotating shutter allows the two wavelengths to fall on to the multiplier alternately. The variations of current from this multiplier are amplified by a three-stage A.C. amplifier, and the final amplified current is rectified by a commutator carried on the same shaft as the rotating shutter. Thus, in general, as the current corresponding to the two wavelengths will not be equal, the galvanometer in the rectified circuit will show a deflection, but if the two rays should produce exactly the same current in the photo-multiplier, there will be no current in the rectified circuit. To use the instrument one of the wavelengths is reduced in intensity by a known amount



with the aid of adjustable optical wedges, and a measurement consists of adjusting the optical wedges until the galvanometer indicates no current, when the position of the wedges is recorded.

It is possible to use the instrument in very weak lights and observations have been made using the light from the zenith sky long after sunset and before sunrise. Measurements can also be taken when the sky is cloudy. For this purpose a third wavelength in the blue part of the spectrum is also employed. Naturally, the measurements taken on cloudy days are not so accurate as those on clear days.

The general appearance of the instrument is shown in the Figure. From the top projects a sun director consisting of a quartz reflecting prism and a lens, by means of which sunlight and moonlight can be focused on to the slit. The instrument cannot be shown in operation, but is shown with its cover removed to expose the internal parts from which the operation of instrument can be appreciated.

Beck No. 50 Universal Microscope†. The instrument shown is the model

for both transmitted and vertical illumination. This microscope has been designed to provide an instrument for visual, projection and photographic examinations by all methods usually employed by microscopists.

The whole apparatus is, as far as possible, constructed as a complete unit with a minimum of attachable parts. Thus, the change from monocular to binocular vision is made by rotating the two bodies in their turret and the change from visual observation to projection or photography by a simple movement. By this method of construction, the rigidity of the whole instrument and its freedom from vibration are ensured. The accuracy and precision of the adjustments are of the highest order and the ease and convenience of manipulation will be appreciated, especially when work is done over a protracted period.

DEMONSTRATION.

No. 48 Microscope with Circular Revolving Mechanical Stage†. This is a new model of the No. 47 series with revolving mechanical stage. The microscope is shown with high power binocular body and a new type of object glass changer. DEMONSTRATION.

Phase Contrast Microscope†. DEMONSTRATION.

Reversion Spectroscope†. A new design in wavelength spectroscopes. Great accuracy is obtained in setting the instrument by adopting the reversion method, in which two spectra are produced adjoining each other, but with the colours reversed. By means of a milled head one spectrum moves against the other in an opposite direction, so that the bands or lines in each can be set to coincide. Setting by this means is definite and more accurate and easy than in instruments where the line is set against a crossline, which is often difficult to see, especially in the darker region of the spectrum. DEMONSTRATION.

Macro-Photographic Apparatus†. This is a very substantially constructed apparatus for the direct photography of objects at low powers. Arrangements are provided for the illumination of both transparent and opaque objects. A series of anastigmatic photographic lenses with foci of ½ in. (12½ mm.), 0·9 in. (23 mm.), 1·65 in. (42 mm.) and 3·25 in. (82 mm.) are made. The camera is quarter-plate size. For photographing at larger magnifications, the apparatus is so made that a microscope can be utilized. DEMONSTRATION.

Laboratory Metallurgical Microscope†. This model has been completely re-designed and greatly improved. The slides in which the focusing movements work have been strengthened and the whole instrument is constructed on very robust lines, to withstand constant use. The microscope is shown with binocular body and Wrighton illuminator. It is also made in monocular form. The object glasses are 'bloomed' to improve their performance with opaque illumination. DEMONSTRATION.

Tenslite Microscope Lamp†. This is a new design in microscope illuminants giving a very brilliant light controllable by a dimming device. The source is a 30 watt closely wound filament. The transformer is built into housing, so that the whole lamp is self-contained. A condenser and light filters are fitted.

DEMONSTRATION.

Reflecting Microscope†. The microscope shown has been developed on

designs from the Wheatstone Laboratory and Medical Research Council Biophysics Research Unit at King's College, London.

It is intended for research purposes with ultra-violet, visible and infra-red light. The objective and condenser consist each of two spherical aluminized mirrors only, the N.A. being 0·65 with approximately 11% of the light energy lost by central obstruction. DEMONSTRATION.

Stand 47

LABGEAR Ltd.,

Willow Place, Fair Street, Cambridge

Range of equipment for Nuclear Physics Research and general Tracer Applications.

Electronic Scaling Unit†. This instrument counts up to 999,999. Two electronic decade scales are employed followed by a 4-figure electromechanical register. It complies with all modern requirements for general work.

Pre-Amplifier†. This is a shielded amplifier unit suitable for use with self-quenching G-M tubes.

Pre-Amplifier (Quenching type)†. This is a shielded amplifier embodying a quenching circuit for use with G-M tubes, either of the self-quenching or non-self-quenching types.

Pre-Amplifier (Cathode Follower type)†. This Pre-amplifier is particularly valuable where the experiment takes place some distance from the main Scaling unit necessitating a long interconnecting lead.

E.H.T. Units†. Stabilized E.H.T. units for G-M tubes and Ionization Chambers giving continuously adjustable voltage up to a maximum of 2 or 4 kv. as required, with reversible polarity.

Discriminator†. For Alpha counting where it is necessary to produce uniform pulses from a random input.

Gamma Monitor†. An instrument designed to measure stray gamma radiation. For use in factories and laboratories employing radioactive techniques. Equipped with warning device as a health safeguard.

Radioactive Prospector†. An instrument designed for field service providing visual and aural indication.

Linear Amplifier. For use with ionization chambers and proportional counters. Separate heads are provided for the low and high frequency spectra.

Radioactive Integrating Meter. An instrument providing continuous monitoring.

General Laboratory Apparatus.

Electronic Relay†. A small device which requires the control contacts to handle only 20 microamps. Will control up to 1 kw. Mains operated.

Lablamp†. A lamp designed for use with microscopes but possessing wide general laboratory applications.

Stand 48

DORAN INSTRUMENT COMPANY LIMITED

Wallbridge Works, Stroud, Glos.

Thermocouple Potentiometer† measuring from 10 microvolts to 50 or 100 millivolts in two ranges, self-contained with sensitive pointer galvanometer and standard cell. This instrument is primarily intended for the accurate measurement of temperature, using base or rare metal couples. It can also be supplied with Potential Divider for checking the calibration of thermoelectric pyrometer indicators.

Mini Thermocouple Potentiometer† with two millivolt ranges and the same accuracy and performance as the standard model, but smaller and mounted in a black laminated bakelite case with lid and carrying strap. Dimensions $8\frac{3}{4}$ in. × $5\frac{3}{4}$ in. × 6 in.

Conductivity Bridge†. Direct reading over the range of 0·1 to 100,000 ohms and 0·00001 to 10 mhos with logarithmic scale giving uniform percentage change of conductivity over its length. (Figure 1).

Oscillator†, mains operated, frequency 1,000 c/s., designed for use with the Conductivity Bridge and fitted in a black bakelite case.

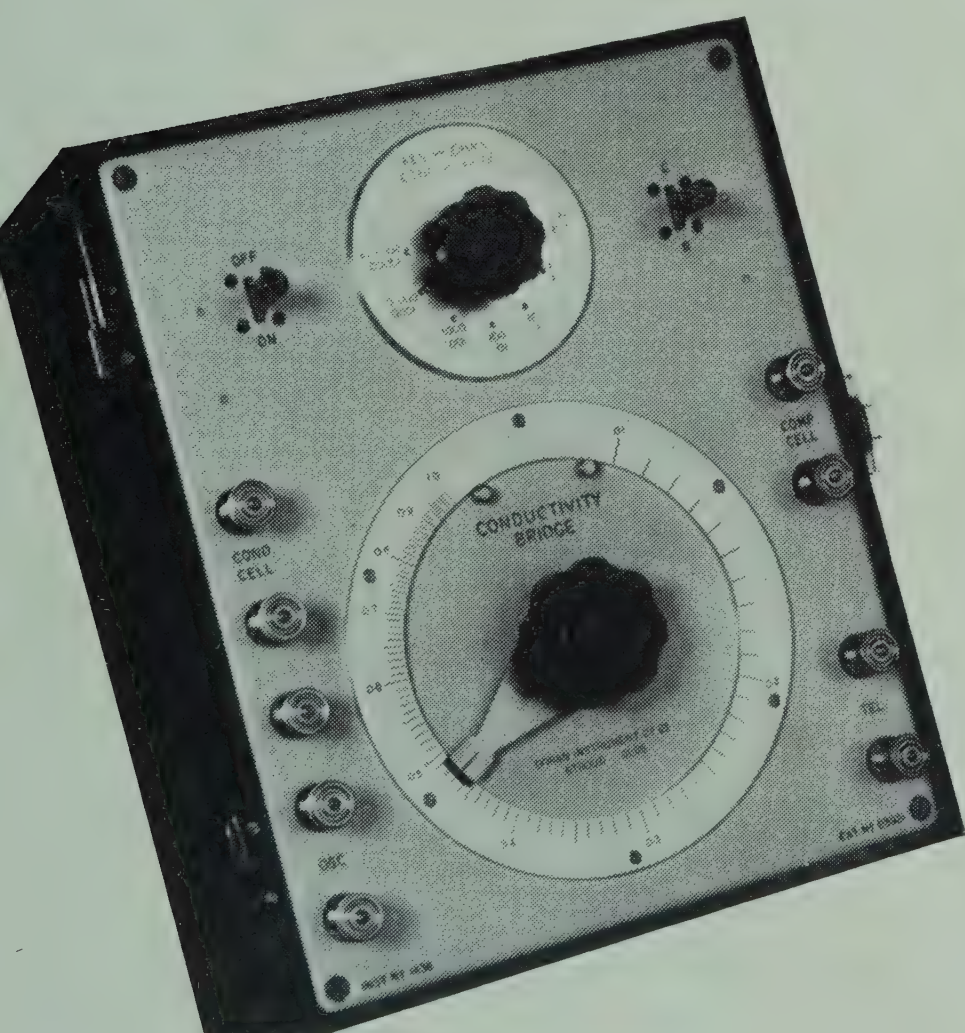


Figure 1.

Figure 2.

General Purpose D.C. Potentiometer† with three ranges, 10 microvolts to 18 millivolts, 100 microvolts to 180 millivolts, and 1 millivolt to 1·8 volts, completely self-contained with reflecting galvanometer, standard cell and 2-volt accumulator. (Figure 2).

Wheatstone Bridge†, self-contained pattern fitted with sensitive pointer galvanometer and provision for connecting to an external galvanometer where

greater sensitivity is required. The dials are arranged to enable the measured value to be easily and rapidly determined.

Reflecting Galvanometer†, strained suspension type, giving robustness, short period and ample sensitivity for most electrical measurements.

Reflecting Galvanometer Unit† with self-contained light source operated from A.C. mains.

Weston Normal Standard Cell 'Dry Type'†. This cell is constructed with the same chemicals and with the same care as the better known Weston Normal Cell, and has the advantage that it may be used in any position. Fitted in metal case with end terminals. Dimensions, 4⅜ in. × ¾ in. × ¾ in., weight three ounces.

Stand 49

BELLINGHAM & STANLEY, LIMITED,

71, Hornsey Rise, London, N.19., and
71a, St. John's Road, Tunbridge Wells

Pan Refractometer†, for direct attachment to the vacuum pan. This instrument indicates the concentration of the solution at any time on a direct reading scale without the use of other optical aid.

Photoelectric Refractometer for use with a continuous flow of the liquid through the prism. The refractive index is indicated on an open scale and in the present instrument a comparatively small range of refractive index is covered and is for use with sugar solutions.

Photoelectric Refractometer for differential measurements of liquids under continuous circulation.

Pocket Refractometer†. Latest type of instrument with improved form of prism box.

Projection Refractometer† fitted with temperature control to the sample.

Contact Refractometer. For many industrial purposes in which a refractometer is used as a means of securing uniformity of a product, it is not essential to know the actual refractive index. A 'number' is all that is necessary, as for instance in the case of the widely used immersion and butter refractometers, both of which have evenly divided scales. On the other hand it is essential to have accurate knowledge of the temperature of the material under test. This is seldom possible, since in the orthodox types of refractometers using water jackets, the amount of water in circulation is so small in comparison with the mass of the glass prism and of the metal water jacket, that it is unwise to assume that the temperature indicated by the thermometer is that of the film of material being examined.

A refractometer is shown fitted to a water container so large that errors due to this uncertainty are eliminated.

In the top of the container two depressions are formed, in either of which fits the refractometer prism face, with its mount. Time being allowed for the refractometer prism to attain a steady temperature, the sample is placed in the other depression and the refractometer transferred to this, when a reading may be obtained which is closely related to the temperature of the circulating water as indicated by the adjacent thermometer. After each reading the prism surface is cleaned, and returned to its former position in order that it may be kept at a constant temperature until the next sample is in place. The circulating water is supplied from any suitable source.

Stand 50

THE WAYNE KERR LABORATORIES, Ltd.,

Sycamore Grove, New Malden, Surrey

The following range of H.F. and V.H.F. Bridges cover the frequency range 15 kc/s. to 250 Mc/s. Up to 100 Mc/s. balanced or unbalanced measurements can be made with equal facility. They have the advantage that the impedance looking back into the terminals and the impedance to ground at balance are very low. Consequently they are free from hand capacity effects and are as stable in operation as the normal type of low frequency bridge.

V.H.F. Bridge Type B.801† (Figure 1). An admittance bridge for use in the frequency range 1 Mc/s. to 100 Mc/s. The difficulties associated with the parasitic elements of standards of large physical size are avoided by using a fixed transformer ratio of 9 : 1 between the unknown and standard. The standard of susceptance is a variable condenser designed to have a low series inductance. In conjunction with the transformer this provides a range of susceptance measurement equivalent to ± 260 pF. High stability carbon resistors are used as standards of conductance. These are mounted on two drums, the first covering the range 0 – 90 millimhos in 10 millimho steps and the second 0 – 9 millimhos in 1 millimho steps. A variable carbon track resistance in conjunction with the fixed standards covers the range 0·1 to 1·5 millimhos.

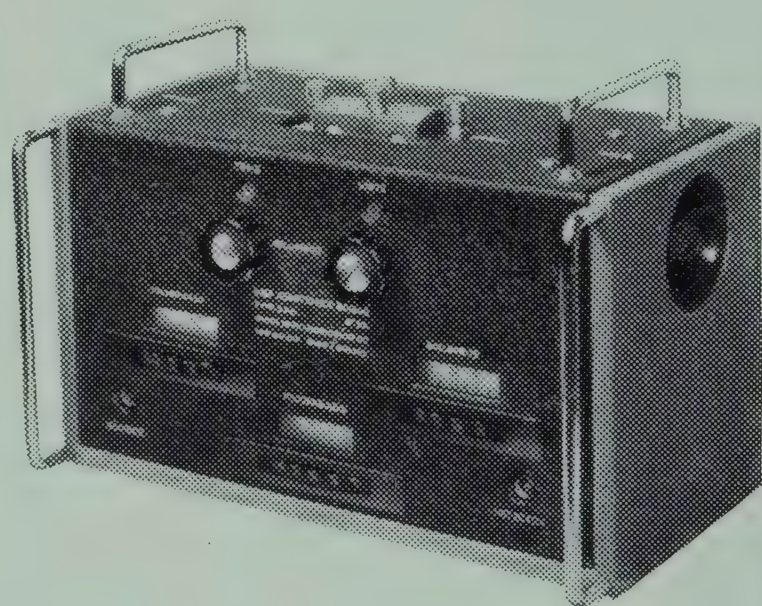


Figure 1. V.H.F. Bridge Type B.801.

V.H.F. Bridge Type B.901† (Figure 2). An admittance bridge covering the frequency range 75 Mc/s. to 250 Mc/s. A fixed transformer ratio of 3 : 1 between unknown and standard provides a range of susceptance measurement equivalent to ± 80 pF. and of admittance between 1 and 100 millimhos. Unbalanced measurements only can be made, and facilities are provided for making a coaxial connection to the unknown.

H.F. Bridge Type B.601† (Figure 3). An impedance bridge covering the frequency range 15 kc/s. to 5 Mc/s. The use of multi-ratio transformers enables a wide range of measurements to be made with single standards for resistance and reactance. Complex impedances which are balanced or unbalanced, or balanced with the centre point earthed, can be measured as well as the impedance between any pair of terminals of a three terminal network.

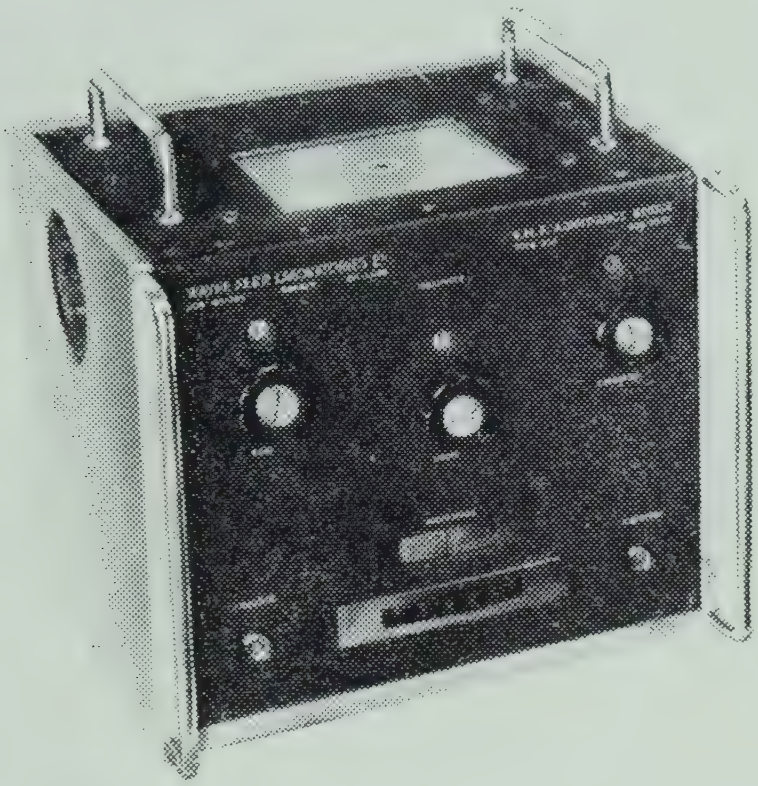


Figure 2. V.H.F. Bridge Type B.901.

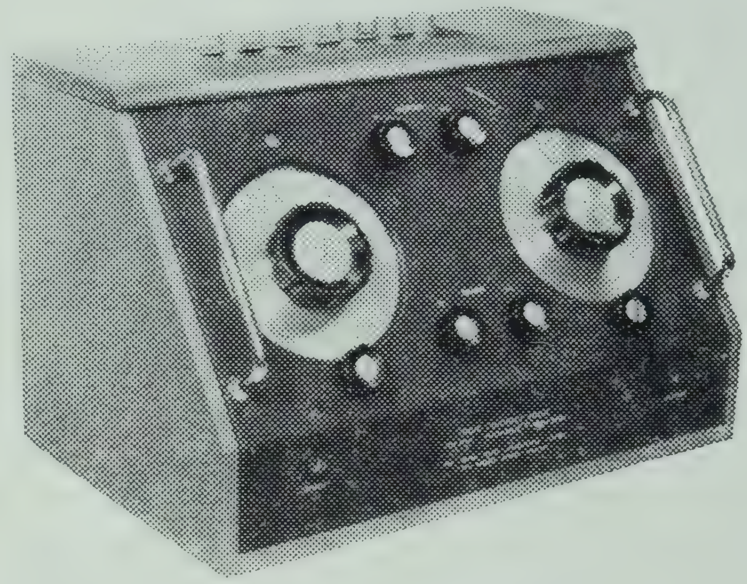


Figure 3. H.F. Bridge Type B.601.

Frequency range	..	..	15 kc/s. — 5 Mc/s.
Capacity range	..	..	0·01 pF. — 20,000 pF.
Resistance range	..	..	10 ohms — 10 Megohms.
Inductance range	..	..	0·5 μH. — 0·5 H.

The accuracy of this instrument is within 1% over the major part of its range.

Demonstrations will be given of an experimental Audio Frequency Bridge employing transformer ratio arms and decade transformers in conjunction with fixed C and R standards in place of conventional variable C and R standards. The combination of decade transformers and fixed standards gives comparable results to those obtained using variable standards of the same accuracy as the single fixed standard. This makes it possible to produce a high precision bridge at a fraction of the usual cost. Furthermore the bridge has the advantage of extremely low impedance looking back into the measuring terminals and low impedances from the terminals to ground. This, together with the facility for making three terminal measurements, removes the ambiguities that generally arise from the parasitic components associated with the unknown.

Audio Frequency Impedance Bridge Type B.271. For the measurement of parallel combinations of R, C or L within the audio frequency band. Employing the same principle as in the High Frequency Bridge, a multi-ratio transformer is used and an unusually wide range of balanced or unbalanced impedance measurements can be made. An arrangement whereby the effect of residual capacity of the leads is neutralized enables the measurements to be made *in situ.*

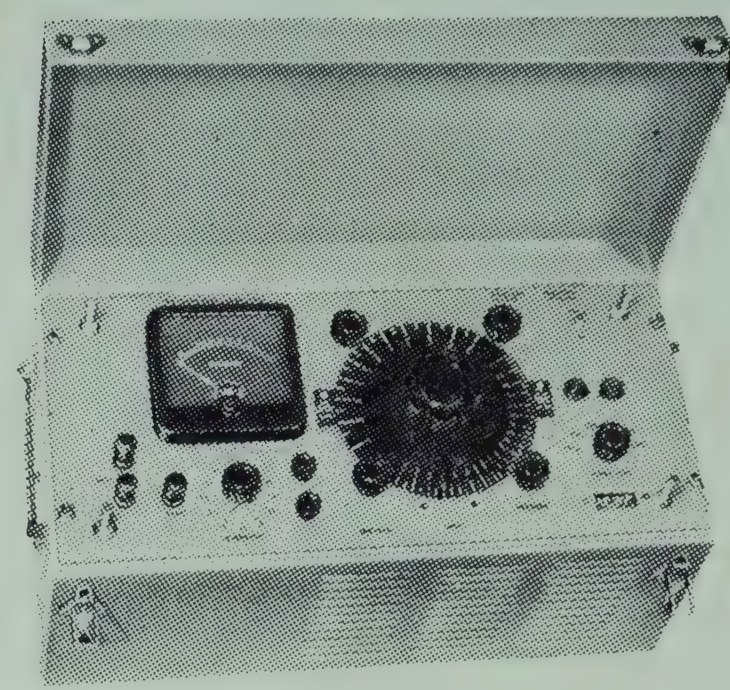


Figure 4.
Audio Frequency Waveform Analyser.
Type 201.

Audio Frequency Waveform Analyser Type A.201† (Figure 4). A superheterodyne type of Analyser covering the frequency range 50 c/s. to 20,000 c/s. in two ranges. Relative voltage levels of the component frequencies of a complex input waveform are measured directly in decibels down to –55 db. with an accuracy of ± 1 db. or down to –65 db. with an accuracy of ± 2 db. at any fundamental input level between –20 db. and + 20 db. relative to 1 mw. into 500 ohms. At the lower frequencies some restriction on the range of measurement is imposed by the bandwidth of the crystal filters in the I.F. Amplifier. These are normally adjusted to provide a level response at ± 5 c/s. from the mid-band frequency of 100 kc/s. and at ± 10 c/s., ± 20 c/s. and ± 30 c/s. the response is –8 db., –30 db. and –65 db. respectively.

Video Frequency Oscillator Type 0-222†. A variable frequency Oscillator covering the frequency range 7 kc/s. to 8 Mc/s. The amplitude variation at any frequency setting does not exceed 0·1 db. Total harmonic distortion is less than 0·2%. It will deliver a maximum output of 1 volt r.m.s. into 75 ohms and an attenuation of up to –65 db. below this level can be adjusted in steps of 0·5 db.

Inductance Meter Type M.148-1†. This instrument provides a simple and direct reading measurement of inductance between 0·05 μH. and 100 mH. A stable variable frequency oscillator is used to resonate the inductance with a fixed standard capacitor. Provision is made for the measurement of capacities between 1 pF. and 1,000 pF. and also of *Q* at the resonance frequency.

Component Bridge Type B.101†. This is a 50 c/s. bridge providing the following measurement facilities :

Capacity	0–500 mF. in eight ranges.
Resistance	0–500 Megohms in eight ranges.
Inductance	0–5,000 H. in four ranges.
Leakage	0–1·5 ma.

Q and power factor measurements can be made. There is also a comparator scale calibrated to within the limits of ± 10% in order to measure components against an external standard. The accuracy of this instrument is to within 2% over the major part of its range. Most of these measurements can be made *in situ* and the terminals of the bridge are normally connected to a flexible lead with crocodile clips.

Decade Potentiometer Type X.419†. Accurately determined resistance ratios between 0 and 1 are provided by a potentiometer of resistance 100,000 ohms. Ratios are selected on 5 decade stud switches. An external D.C. supply is used and the slider is connected to an internal Galvanometer having a sensitivity of 0·2 μa/mm. Ratios between 0·1 and 1·0 can be measured to an accuracy of 0·01%.

Stand 51

J. W. TOWERS & CO. Ltd.,

Victoria House, Widnes

Towers Model 200 Automatic Direct Reading Balance† (Figure 1) of 200 gm. capacity and 0·1 mg. sensitivity is a single pan balance of radically new design. As all weighings are carried out with the case closed, the weights from 0·1 to 199·9 gm. being operated by four control knobs and the total weight of the sample read off a direct reading indicator, it is the most rapid weighing and the most easily operated balance yet made in this country.

The balance operates under constant load and therefore the sensitivity is constant. It eliminates beam length errors, reading errors and errors due to corroded or worn weights.

The load on the beam is always brought to 200 gm. at every weighing by removing weights equal to that of the sample. The weight less than 0·1 gm. is shown optically on the illuminated scale and can be read to 0·1 mg. (half a division). The balance is air-damped and comes to rest quickly.

The planes are of optically flat synthetic sapphire (corundum) and the case of aluminium with glass base to the weighing compartment.

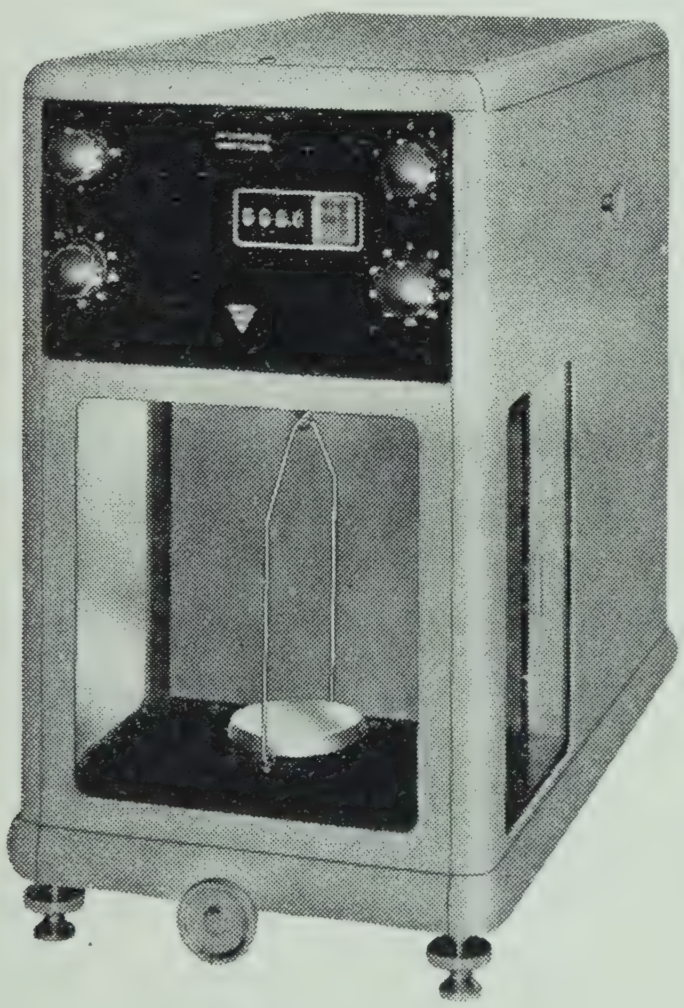


Figure 1.
Towers' Model 200 Automatic Direct Reading Balance.

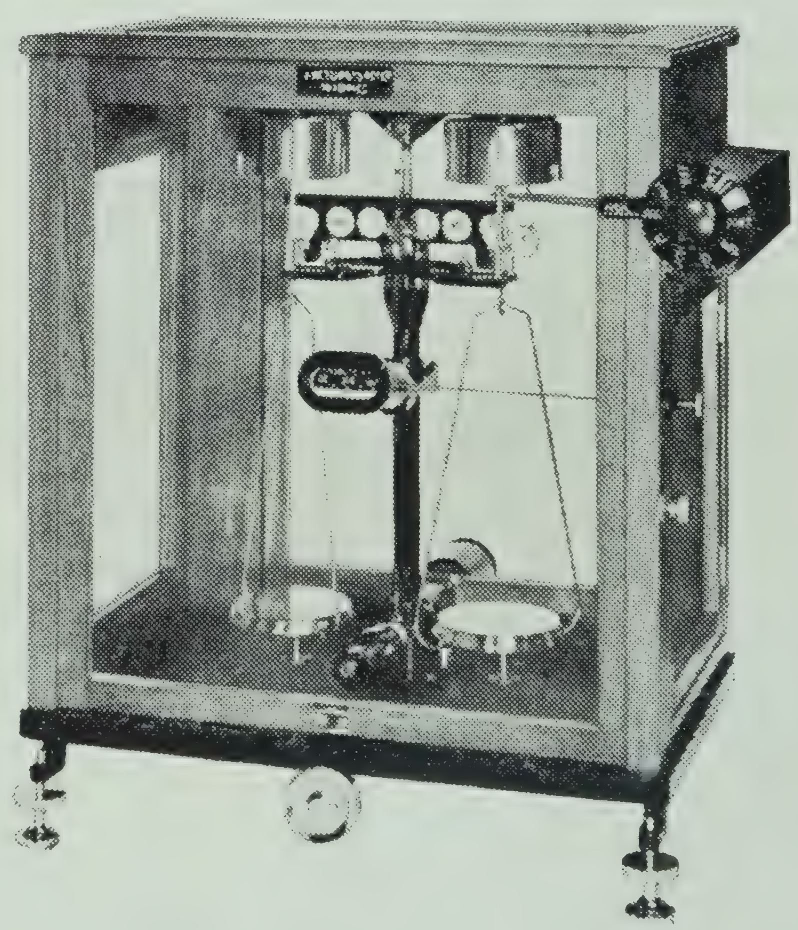


Figure 2.
Towers' Model 98 Air-damped Balance.

Model 98 Air-damped Balance† (Figure 2) has capacity 200 gm. and sensitivity 0·1 mg. This is a new model for rapid weighing which does not require weights below 1 gm. It is fitted with air-damping cylinders which quickly bring the balance to rest. The pointer carries a photographic graticule divided 0 – 100 mg. in 0·2 mg. divisions and by means of an optical system a

magnified image is projected on to the eye-level screen. Readings are made to 0·1 mg. (half a division) without the use of a vernier.

The balance is provided with four ring rider weights totalling 900 mg. which are operated by a dial outside the case.

The planes are optically flat synthetic sapphire (corundum).

Towers Universal Electric Laboratory Oven† (Figure 3) with thermostatic control 40 to 180°C. ± 1°C.

The outer case is of sheet steel which is rust-proofed and cream stove enamelled. The easy-close door catch, hinges and ventilators are chromium plated.

The inner oven is of stainless steel and the whole oven including the door is well insulated with glass silk.

The heating elements are totally enclosed and are placed at the sides and bottom of the oven, giving uniform heating and increased safety when drying inflammable substances.

Temperature control is by means of a bi-metallic thermostat which operates through a relay, eliminating all sparking at the contacts. The thermostat dials are individually calibrated in degrees centigrade, and are not merely an empirical scale.

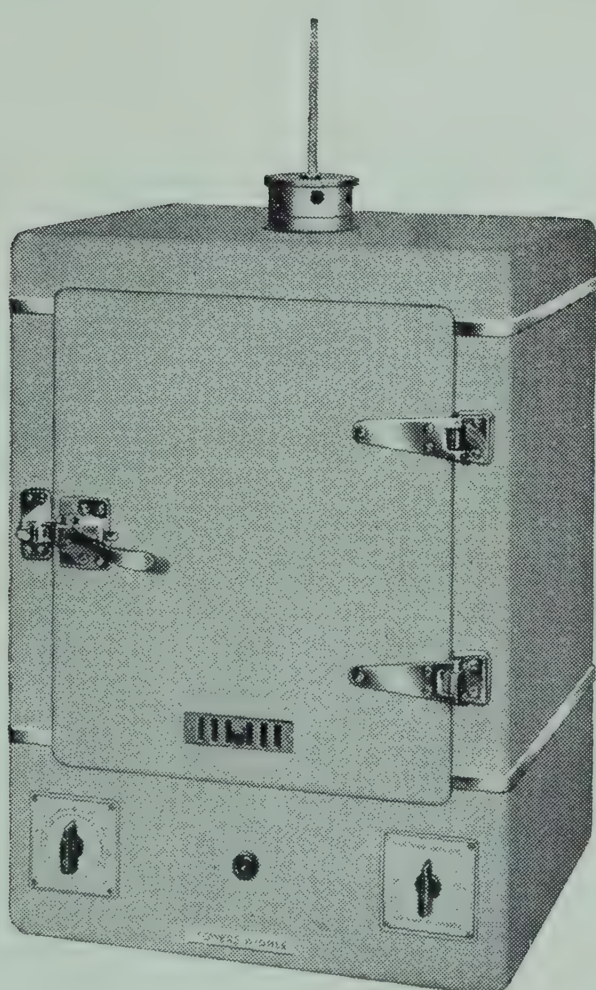


Figure 3.
Towers' Universal Electric Oven.

Figure 4.
Towers' I.P. Thermostat Bath.

I.P. Thermostat Bath†. Designed to comply with the specification in " Standard Methods for testing Petroleum and its products " for the determination of kinematic viscosity using glass U tubes. The temperature can be maintained from 68° – 210°F. within ± 0·025°F.

It consists of an inner glass bath 14in. deep by 9in. diameter with an outer glass bath for insulation, fitted with black plastic end plates and levelling feet. The top plate carries the heaters, stirrer bracket, thermostat and thermometer

and is fitted with a centrally rotating disc for holding four glass U tube viscometers. In order to obviate vibration and to keep the top of the bath as free from obstruction as possible, a flexible drive stirrer is provided, with the motor placed on the bench. A separate control panel is provided with variable transformer and all the necessary switches, resistances, etc. (See Figure 4.)

Vacuum Drying Apparatus† for heating quantities of approximately 100 gm. of material under vacuum and at any pre-determined temperature up to 150°c. in the presence of a drying agent.

Automatic Temperature Controller†. A new instrument based on electronic principles for automatically maintaining the temperature of an electric furnace at any desired temperature.

It is operated by a thermocouple placed inside the furnace, the pyrometer indicator of which is fitted with an additional pointer which is set at the required temperature. This pointer is connected to a Fielden Tektor Meter Relay circuit and when the temperature indicating needle reaches it, the electrical capacity of the circuit is affected and a relay is operated. Similarly, when the temperature drops, the supply is switched on again.

An accuracy to within 1% of the scale range, or better, is attainable.

Stand 52

L. OERTLING LIMITED,

110, Gloucester Place, Portman Square, W.1

Aperiodic Prismatic Reflecting Weight Loading Balance Model 62 FM† (Figure 1). This instrument has a capacity of 200 gm. in each pan, and the sensitivity is 0·2 mg. per graticule division. The spacing of the division on the screen is 1·5 mm. It is fitted with Corundum planes in place of the traditional and much softer Agate. Following research a method has been developed by which Corundum planes can be produced and polished optically flat. This material is harder and more durable than any other, except diamond, and prolonged tests by Oertling have shown that when matched with agate knives, the result is a bearing of extreme accuracy and durability.

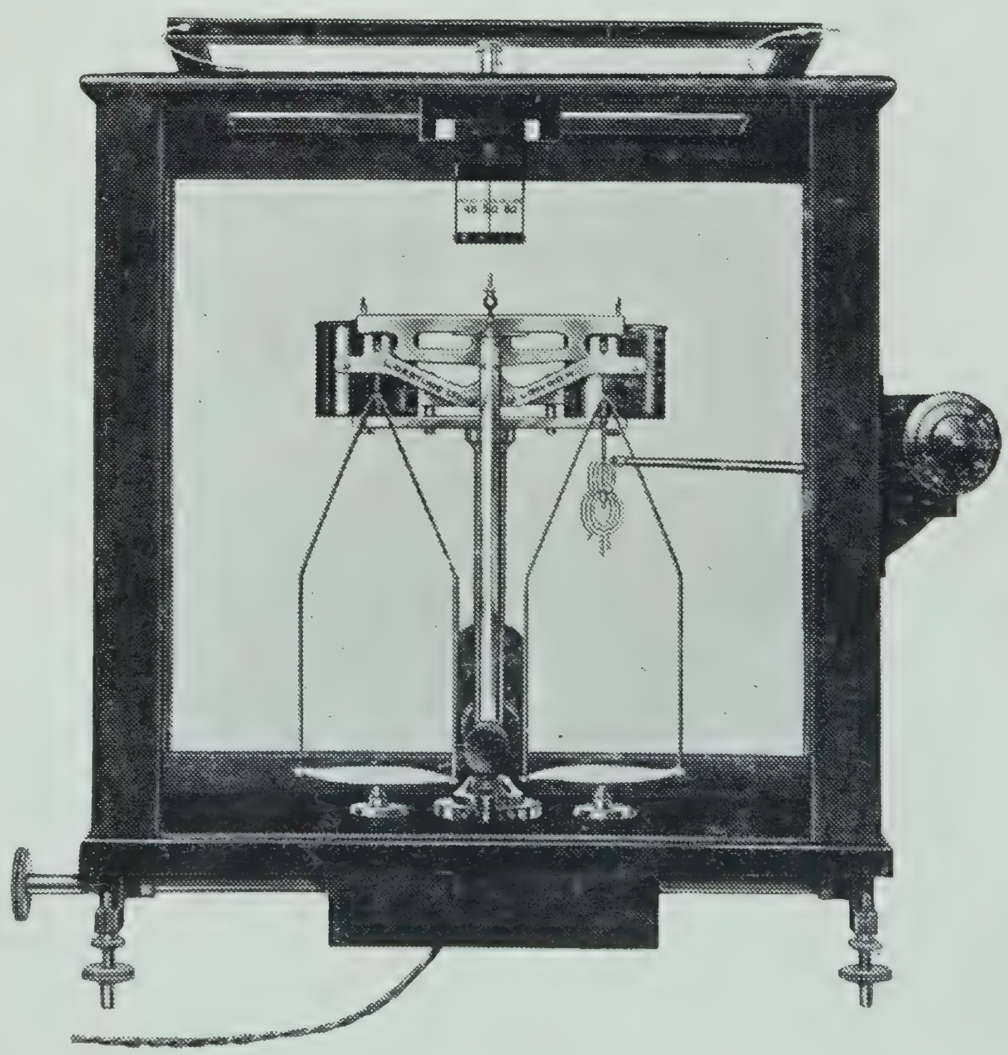


Figure 1. Model 62FM. 0·1 mg. per ½ division.

This balance is equipped with an optical projection system providing a particularly clear graticule image on the ground glass screen. It can be read from quite a wide angle and under all normal conditions of lighting without strain. The screen is placed at the top of the case in order to provide as large an image as possible and to keep the base of the balance case free from encumbrances. The aperiodic damping system is extremely efficient and gives rapid operation.

A calibrated dial operated weight loading mechanism is provided. By this means varying weights up to a total of 0·99 gm. may be added to the right arm of the beam. The graticule covers the range to 0·01 gm. and it is thus possible to obtain a total displacement of 1·0 gm. Weights below this value are unnecessary, and it is therefore easily appreciated that weighing operations can be carried out with ease and very speedily.

The rider weights are of nickel-chromium. Careful attention to detail has produced a mechanism which is smooth, positive and completely reliable, and there is no risk of the rider weights taking up varying positions on the bar during successive operations. The careful design and technical superiority of this instrument ensures accurate weighing over very long periods.

Prismatic Reflecting Micro-Chemical Balance Model 63PA/PB† (Figure 2). This instrument has a Direct Reading Sensitivity of 0·001 mg. per graticule division. Capacity is 20 gm. for each pan.

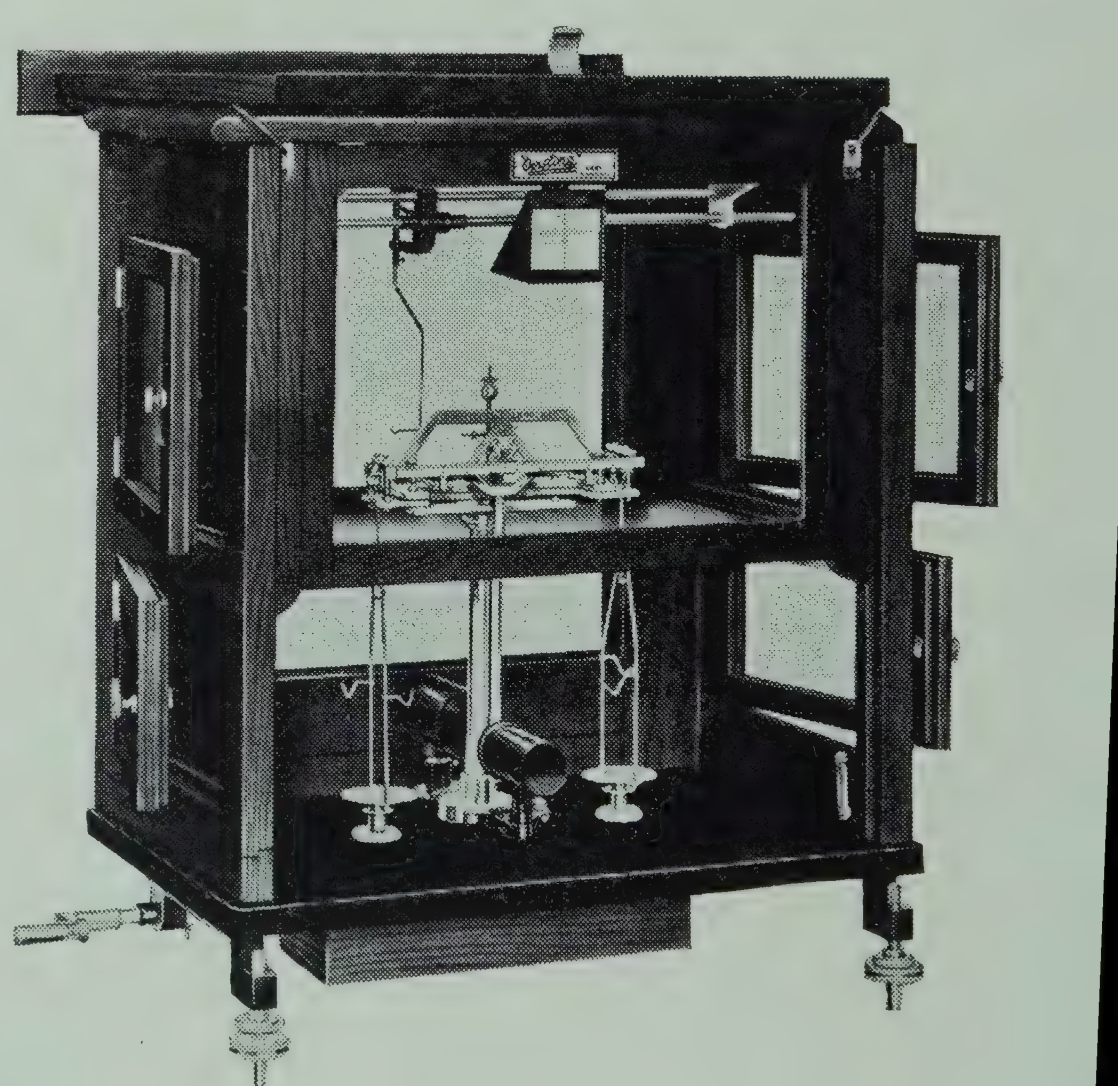


Figure 2.
Model 63PA/PB (without outer case) 0·001 mg. per division.

A 5-inch non-magnetic nickel-chromium beam is employed to which is attached a co-planar rider bar carrying 101 notches. These notches are produced simultaneously by a special Oertling tool, recently developed to eliminate the errors in notch positions which may arise when the conventional single cutter and lead-screw are used. The balance is adjusted for use with a 5 mg. rider. The beam is in a compartment separated from the remainder of the balance case by a glass shelf, thus removing temperature effects during the opening and closing of the front slide or side doors. Separate front slide and side doors are provided for the beam compartment. In addition, the balance case is housed in a larger outer case, with counterpoised front slide, to increase further the instrument's stability under changes of ambient temperature.

The projection lamp for the optical system is mounted outside the large outer

case, and the light is passed to the first optical condenser through a window of Calorex glass, so preventing any heat from the lamp penetrating to the balance case.

Hooks for Absorption Tubes are fixed to the pan wires.

There is no Continental balance of comparable design and specification.

Aperiodic Prismatic Reflecting Micro Balance Model 141† (Figure 3). The design of this instrument is basically the same as model 63 PA/PB Micro-chemical balance. It has a Direct Reading Sensitivity of 0.01 mg. The capacity is 30 gm. for each pan. The beam is in a compartment separated from the remainder of the balance case by a glass shelf. Separate front slide and side doors are provided for the beam compartment.

The projection lamp for the optical system is mounted outside the case, and the light is passed to the first optical condenser through a window of Calorex glass, so preventing any heat from the lamp penetrating to the balance case. Automatic weight loading up to 0·09 gm. is provided, which with the graticule range of 0 to 0·01 gm., gives a total displacement of 0·1 gm. All rider weights are of nickel-chromium. An efficient air-damping system ensures rapid operation of the balance. Hooks for Absorption Tubes are fixed to the pan wires. Careful attention to design has rendered this instrument one of exceptional speed, accuracy and stability.

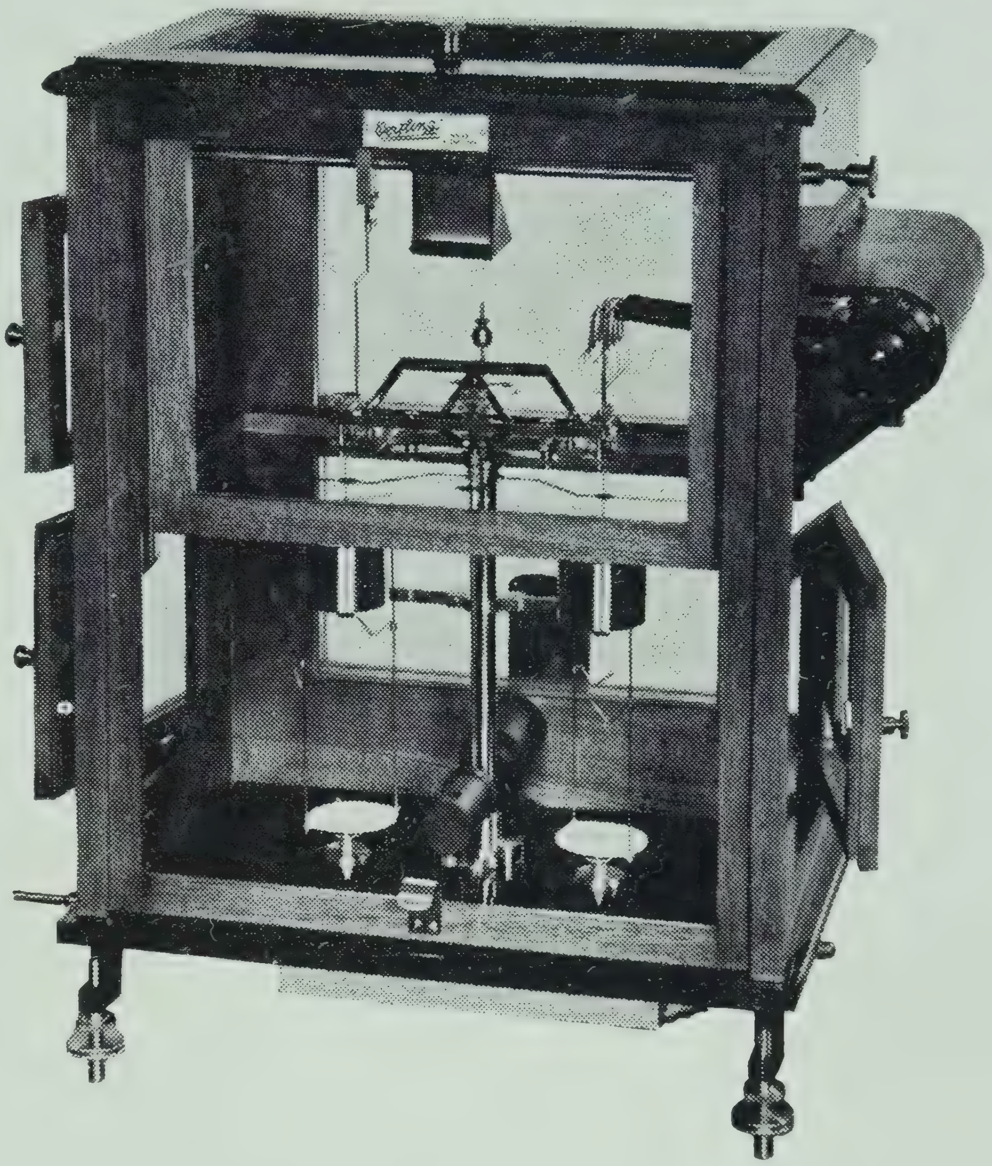


Figure 3. Model 141. 0·01 mg. per division.

Photo-Elastic Test Apparatus for Balance Beams† (Figure 4). Uniform

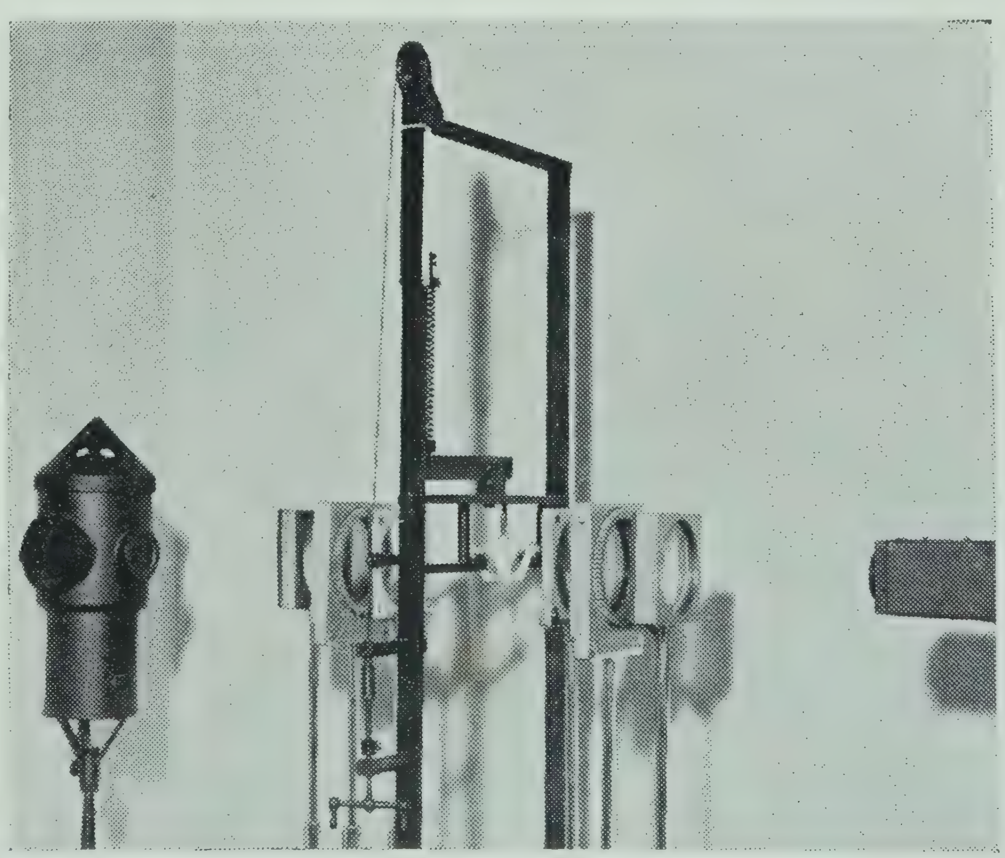


Photo *Chemical Age*

Figure 4.
Photo-Elastic Test Apparatus for Balance Beams.

stress distribution in balance beams is essential if the beam is to have maximum rigidity combined with minimum weight. Rigidity of the beam is important for ensuring that the sensitivity of the balance is independent of the load in the pans and minimum weight of the beam gives the minimum time-period to the instrument, thus enabling rapid routine weighings to be performed.

The apparatus illustrated is a conventional polarimeter used in the Oertling Research Laboratories, adapted for the viewing of stress patterns in plastic models of balance beams. The beam is mounted inverted and held at each end, the load being applied at the centre by a vertical pin actuated by a lever-arm and graduated spring. Provision is made for either photographic recording or direct viewing of the stress patterns.

Microchemical Balance Arrestment Mechanism†. A model showing the construction and operation of the arrestment mechanism as fitted to microchemical and semi-microchemical balances is shown. It enables the details of the 3-point jewel-arrestment to be studied and in particular the smooth and even operation of the release mechanism.

Automatic Weight Loading†. A model is shown, which enables the construction and operation of the automatic weight loading devices as fitted to Oertling balances to be appreciated. The smooth operation of the device results from careful attention to the detailed design of the cams and lifting arms.

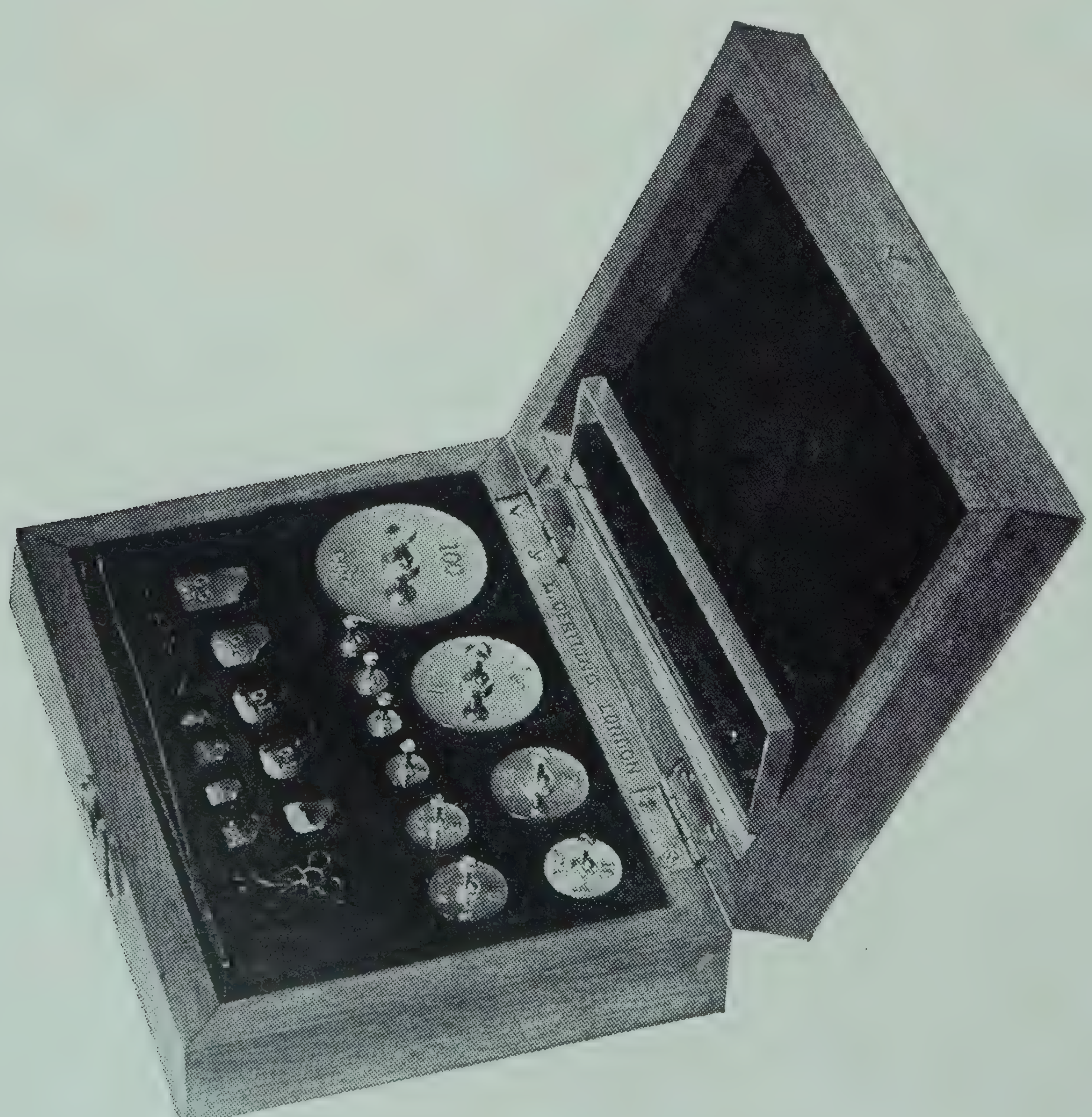


Figure 5. Oertling Nickel-Chromium Weights.

Nickel - Chromium Weights† (Figure 5). The ideal analytical weight should be made of hard metal which is corrosion resistant to both oxidizing and sulphur fumes and is non-magnetic.

Oertling Nickel-Chromium Analytical Weights are more durable than brass, bronze, nickel, stainless steel or other metals from which analytical weights are made. They are also more durable than plated weights.

The fractional weights, which must be handled on balances other than the Gram-chain and Prismatic models are subject to wear attendant to this operation. Nickel-Chromium is so tough that it is impossible to make any impression on it by the ordinary handling in weighing operations.

Oertling Nickel-Chromium Weights resist corrosion much better than brass, bronze, similar alloys and stainless steel. While stainless steel and gold have resistance to oxidation, they do not withstand the fumes of sulphur and other chemicals which are present in small amounts in many laboratories. Even weights made of stainless steel will tarnish. Oertling Nickel-Chromium Weights are non-magnetic. This is a primary requirement. They are meticulously adjusted on balances which were designed specifically for the purpose, to meet the exacting specification of tolerance set up by the N.P.L. The extent to which Oertling Nickel-Chromium Weights maintain N.P.L. evaluations from year to year is an important reason why they should be employed rather than weights made of materials susceptible to conditions that bring about error-producing changes in the weights.

Oertling Nickel-Chromium Weights are fitted with screw type knobs to permit of adjustment at any time, and therefore, if changes should occur due to accidental damage, such errors can always be corrected with the minimum of cost and inconvenience.

	Code Word
100 gm. to 10 mg.	ENTLO
50 gm. to 10 mg.	ENTRO

Adjustment. The accuracy of these weights is such that they will be found to be within tolerances which are never greater than, and in many cases, smaller than that permitted in the National Physical Laboratory Class A Test. Even with all the weights within the permitted tolerances, it would still be possible to get cumulative errors in using a number of weights together. *Oertling weights are so inter-calibrated that errors of this type cannot arise.* All weights are stabilized before despatch.

If required, N.P.L. Certificate of Values or Verification can be supplied.

Fractional Weights included with the Nickel-Chromium Analytical Weights are made of Nickel-Chromium wire down to 0·01 gm. Our experience indicates that there is little demand for weights below 1 cg. and we therefore do not include them with standard boxes of weights. They can, however, be supplied if specially requested ; the box is designed to accommodate them in the tray with the other weights. Each set is furnished in an attractive, white velvet lined, polished mahogany case, and tipped forceps are included.

Nickel-Chromium Microchemical Weights† (Figure 6). These are sets of special weights made from Nickel-Chromium for microchemical and semi-microchemical work. Supplied in polished mahogany boxes lined with velvet.

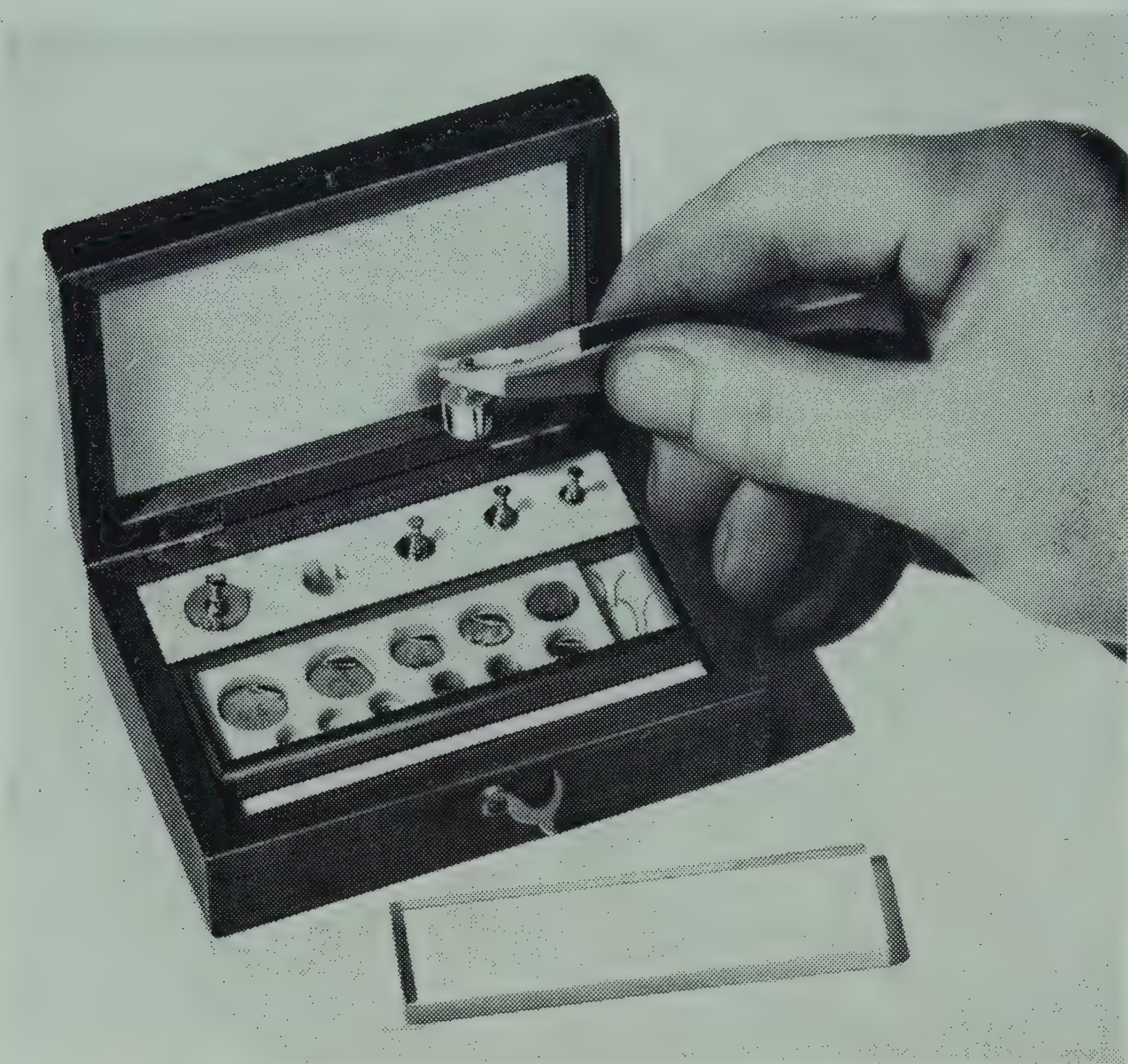


Figure 6. Oertling Nickel-Chromium Micro Weights.

The set is of the 5, 3, 2, 1 series and is complete with three 5 mg. riders specially adjusted to within 0·01 mg. Tipped forceps are provided.

			Code word
Set of 20 gm. to 10 mg.	..	..	EMI
Set of 10 gm. to 10 mg.	..	..	EI

The accuracy of these weights is adjusted to be as near standard as possible, but in no case is an error permitted greater than half N.P.L. Class A. The weights are interchecked so that cumulative errors cannot arise in use. They can be supplied with an N.P.L. Certificate of Values or Verification.

Individual Weights†. Oertling are always pleased to supply individual weights to make up sets which have become incomplete. All individual weights are guaranteed to be within the appropriate tolerance for their denomination and type.

Stand 53
AIRMEC LABORATORIES Ltd.,
Cressex, High Wycombe, Bucks.

H.F. Millivoltmeter Type 762. This instrument has been designed for use at frequencies between 1 Mc/s. and 500 Mc/s.

The input is applied to a crystal rectifier circuit which is followed by a magnetic amplifier. The output from the magnetic amplifier operates a moving-coil meter, which is calibrated directly in millivolts. Three ranges are provided : 0–150, 0–500 and 0–1500 mv.

Frequency Substandard Type 761†. In this equipment a crystal-controlled two-valve oscillator operates at 100 kc/s. The crystal is temperature controlled to within $\pm$ 0·25°C. and operates at its parallel resonant frequency. Dividing networks are provided and pulse or sinusoidal outputs at 100 c/s., 1 kc/s., 10 kc/s., 100 kc/s., and 1 Mc/s. are provided. Unknown external frequencies can be compared visually on a 2½ in. cathode-ray tube, or audibly by means of a beat note detector, amplifier and speaker. For long period stability checks a 50 c/s. synchronous clock is fitted and runs from the divider chain. This can be checked against standard time transmissions and a short period stability of better than 1 part in 10^6 is obtained. The Substandard is self-contained and operates from 200–250 volt A.C. mains 50 c/s.

Miniature Oscilloscope Type 793†. Occupying small bench space, this Oscilloscope has been designed for laboratory, workshop or educational use. The tube is 2½ in. dia. and the internal 'Y' amplifier has an overall gain of 700. This amplifier has a linear response from 30 c/s. to 100 kc/s. and is also useful above this frequency. A time-base ranging from 10 c/s. to 30 kc/s. is provided and the usual focusing, brilliance, synchronizing, gain, and shift controls are fitted. Direct connection to the 'X' and 'Y' plates can be made. A feature of the instrument is the provision of two power packs both separate from the Oscilloscope proper. One, A.C. mains or 6-volt battery operated, is suitable for running one oscilloscope. Up to five oscilloscopes at a time can be run from the second type of power pack, which is A.C. mains operated only.

Airmec Colour Comparator Type 751. The Airmec colour comparator can be used for : matching one colour with another in terms of any of the constituent colours ; maintaining colours of constant constitution relative to a white or coloured standard ; determining the proportions of different colours present in a pigment relative to standard or desired proportions, comparing surfaces of like colours but of unlike reflective characteristics.

Specimens and standards are set up under the same illuminating source with suitable colour filters. A photoelectric pick-up is used and an indication is given on a cathode-ray tube in the form of a pair of signals for each colour.

The relative amount of each colour is proportional to the height of the signal trace and means are provided for calibrating this, so that direct readings can be taken.

D.C. Oscilloscope Type 723† (Figure 1). This is a general purpose instrument incorporating many advanced design features. The balanced 'Y' amplifier has a gain frequency response flat from D.C. to 5 Mc/s. An auxiliary or 'Z' amplifier is also fitted which can be used for beam modulation. The

time-base is variable from 0·5 second to 1 microsecond single sweep and the fly-back is fully blacked out. A single stroke time-base is also provided. The tube can be operated at 1 kv., 2 kv. or 4 kv. and automatic brilliancy control is incorporated to vary light intensity with speed of trace for photography. Shifts are symmetrical and instantaneous, and internal or external automatic synchronization is provided.

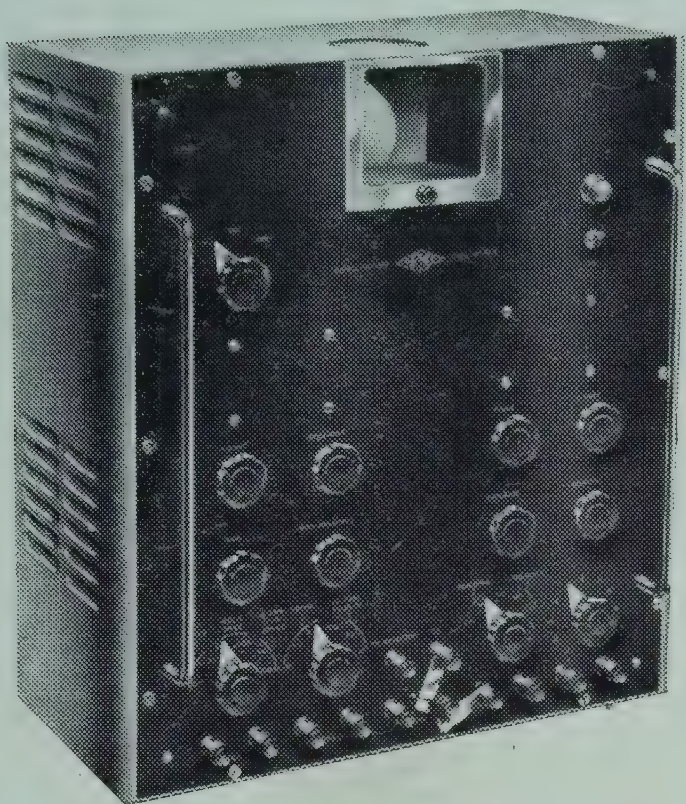


Figure 1.

Oscilloscope Camera Type 758†. This camera has been designed especially for use with the Airmec Type 723 Oscilloscope. It is electric-motor-driven and in operation stands directly on the Oscilloscope ; both components occupy minimum forward dimensions. The camera accommodates 100 feet of standard 35 mm. cine film. Single or continuous records can be taken and an indicator shows the amount of film exposed. A simple control gives three film speeds i.e., 6 in., 1 ft. 6 in., and 4 ft. 6 in. per second.

Heterodyne Bridge Detector Type 754†. The instrument consists of a frequency changer, a beating oscillator, a tuned amplifier, and a detector. It covers the frequency range 9 kc/s. to 750 kc/s. The input circuit termination is a screened and floating transformer making the instrument suitable for direct connection to bridges. Out of balance bridge voltages down to 1 microvolt may be detected. A calibrated attenuator is provided so that the instrument may be used as a wave analyser.

Electronic Counter Type 704†. This instrument incorporates six decades, allowing a count of 0 to 999,999. It will operate on regular or irregular pulses and cycles up to one hundred thousand counts per second and on an input anywhere between 1·0 and 25 volts peak. The decades are unit constructed, and interchangeable, each unit containing four valves and their circuit components. The count is shown by neon indicators behind numbered apertures.

The counter may be used for high speed counting in a wide range of industrial applications, or for velocity and timing by means of suitable operating devices.

Figure 2.

Radiation Monitor Type 1021† (Figure 2). The Radiation Monitor is suitable for comparative and absolute measurements and for general tracer work. It is a convenient instrument for detecting radioactive contamination of workbenches, floors, chemical equipment, and the clothing of personnel who are engaged with radioactive material.

The instrument will detect and measure alpha and beta particles and gamma radiations. Suitable probes are provided for each application and the probes are

connected to the instrument by a flexible lead. A moving-coil meter gives a direct reading of intensity of radiation. A loudspeaker, which can be switched in or out at will, gives audible indications of radioactivity and is useful when the meter reading is inconvenient.

Stand 54
W. F. STANLEY & CO. Ltd.,
New Eltham, London S.E.9

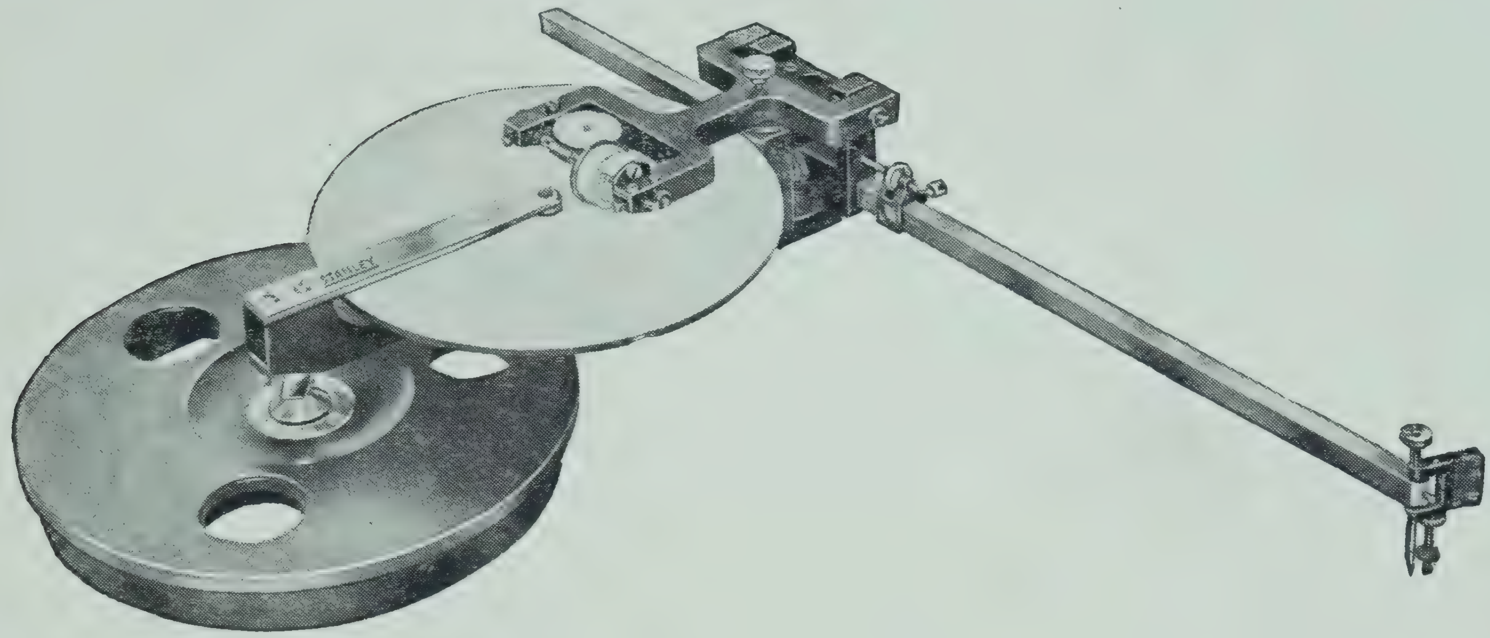


Figure 1. Precision Disc Planimeter.

'Allbrit' Precision Disc Planimeter† (Figure 1). One of the most accurate planimeters ever produced, this recent addition to the 'Allbrit' range of instruments is an elaboration of the polar planimeter, in which the measuring wheel travels on a matt-surfaced disc. Movement of the tracer arm about the 'pole' causes a relatively great rotation of the disc which is communicated to the measuring wheel resting upon it. This feature increases its sensitivity and makes the planimeter especially suitable for small areas, which under suitable conditions may be measured to within 1/500 square inch.

Other instruments, now in production, in this extensive range, include the 'Allbrit' Rule-Form Planimeter particularly adapted for averaging readings on drum charts, the 'Allbrit' Continuous Chart Planimeter, the 'Allbrit' Rail-Type Planimeter (carriage attachment), for measuring very large areas and a series of Special Radial Planimeters, each designed to suit a particular circular record chart having square root or other non-uniform spacing.

Stanley Integrator No. 3†. This model, having four integrating units, will evaluate

$$\int y^n \, dx \text{ for } n = 1, 2, 3 \text{ or } 4.$$

It is thus suitable for the measurement of areas, static moments, volumes and moments of inertia of plane and solid figures.

The Stanley Integrators have many applications in naval architecture and in mechanical, civil, and aeronautical engineering, combining a high order of accuracy with rapid operation.

Stanley Harmonic Analyser, Mader type (Figure 2). By means of planimeter readings, this analyser gives the values of sine and cosine coefficients in a Fourier series representing the periodic function whose curve is traced. Adjustment is provided to cover various lengths of fundamental period.

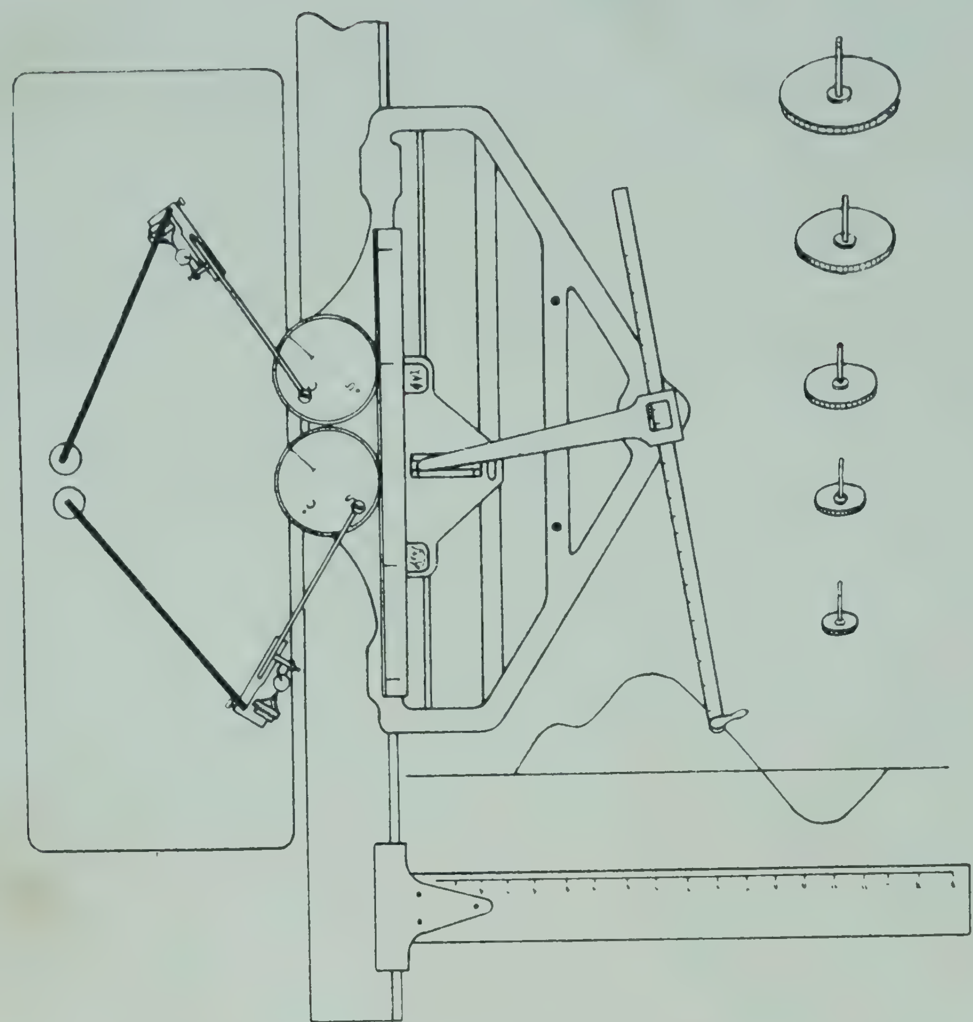


Figure 2. Harmonic Analyser.

Figure 3. Integraph or Continuous Integrator.

Stanley Integraph or Continuous Integrator† (Figure 3). This instrument follows the design of Abdank-Abakanowicz ; its general arrangement is shown in the accompanying illustration.

When made to follow a given curve representing $y = f(x)$ this instrument will describe the corresponding integral curve $\int f(x)\,dx$, thus providing a continuous record of the progress of integration. Its operation depends on the guiding action of a knife-edged wheel whose inclination relative to the x-axis is maintained proportional to the ordinates of the given curve.

Stand 55

THE BRITISH IRON and STEEL RESEARCH ASSOCIATION,
11, Park Lane, London, W.1

Automatic Bore Profilometer*. This instrument is a further development of the wire drawing die profilometer, an experimental model of which was exhibited at the Physical Society Exhibition of Scientific Instruments in 1948. This later instrument is automatic in operation and thus permits plotting of bore profiles very much more quickly than was possible with the original hand-operated instrument.

After the die has been set up in its chuck and the probe arm adjusted in the entry to the die bore, the instrument can rapidly trace and record on an enlarged scale the profile of the bore to an accuracy of 0·0001 in. (0·0025 mm.)

Movement of the probe tip which bears on the internal surface of the die bore rotates the pivoted arm which carries the probe and the small mirror fixed to it. An optical system using a light source, beam-splitting prism and photocells, is used to detect rotation of the mirror in place of the autocollimator used in the original instrument. The signal obtained from the photocells corresponding to deviation of the mirror from a reference angle of inclination is amplified and applied to the control field winding of a two phase servo-motor. This motor, through suitable gearing, drives the spindle controlling the vertical movement of the pivot carrying the probe arm. As the probe arm carriage is moved horizontally, thus causing the probe tip to traverse the die bore, the servo-motor automatically resets the probe arm pivot height to maintain the mirror at the fixed inclination. Thus within certain limits of speed of traverse, set by the following-up speed of the servo system, the vertical movement of the pivot spindle and its associated driving mechanism continuously follows and reproduces the profile of the die bore.

The driving shafts which control the horizontal translation of the probe arm carriage and the vertical movement of the pivot spindle are connected by flexible drive cables to the respective inputs of a specially designed rectangular coordinate plotting table. Thus a magnified trace of the bore profile is drawn on the plotting table while the measurement is being made.

Gas Flow Meter†. The instrument is designed for measurement of flow rates using an orifice or similar restriction in the flow line. Among its particular virtues are its ability to operate on a low range of differential pressure of the order of 0·5 in. W.G. (12·7 mm. W.G.) and below, and give a linear scale of flow rate. The instrument reading is displayed on a standard moving-coil milliammeter or recorder which can be fitted at any position remote from the measuring head. The instrument also has a rapid response, of the order of ½ second to register 95% change in flow rate.

The principle of operation is as follows :

The differential pressure across the orifice is applied to a freely mounted diaphragm whose motion is restrained by the opposing force set up by a coil carrying a current and situated in the field of a 'pot' electromagnet. The electromagnet

* A hand-operated version of this instrument is being made by Hilger & Watts.

† This instrument is developed from the roof pressure meter exhibited in 1948, which is being made by Tinsley Industrial Instruments Ltd.

is excited by the same current as the coil. This current is provided via an amplifier and rectifier from a sensitive electrical displacement detector responding to small movements of the diaphragm from an arbitrary zero. Thus on application of a differential pressure, the diaphragm will displace a small amount and then reach a state of equilibrium in which the force on it due to the coil exactly balances that due to the applied differential pressure. In this condition the current in the coil, being proportional to the square root of the force it produces, is linearly related to the flow rate, since the pressure measured across the orifice is proportional to the square of the flow rate.

High Temperature Microscope. This microscope has been designed for the microscopic examination of metals at high temperatures. In this instrument an optical system of unit magnification comprising a spherical mirror and a half silvered plane, produces a real image of the specimen ; this optical system has a N.A. of 0·7 and a working distance of 1·7 cm. The real image thus produced, although not magnified, is accessible, whereas the heated specimen is not, and this image may be examined by an ordinary microscope, thus giving the required magnification. The specimen is illuminated obliquely, the light being introduced through the bottom of the furnace and the optical components of the illuminator being mounted inside the vacuum furnace.

Pitot Tube for Measuring the Velocity of Hot Gases. When making measurements of the velocity of ingoing preheated air or gas in open hearth furnace systems it is impossible to use an ordinary Pitot tube because of the high temperature (1000 – 1300°c.). In addition, the presence of corroding slag particles is a difficulty. Water-cooled tubes have been used with apparent success but there is some doubt as to whether the coefficient of the tube is rendered unstable by the large difference in temperature between the cold tube surface and the high temperature gas being measured. Heat-resisting steel will withstand the temperature required for a short time but tends to bend. A new type of tube has been designed in which the heat-resisting steel outer tube carrying the dynamic and static heads is supported at point intervals on a water-cooled central rod so that the outer tube may approach the temperature of the gas being measured and yet be supported on contact points which do not permit the loss of much heat to the central water-cooled rod.

Pitot Tube for Measuring the Velocity of Hot Gases. This type of tube consists of a circular water-cooled disc with pressure tappings in the centres of the two faces.

The disc is made several inches in diameter in order that the Reynolds number may be sufficiently high under conditions of low velocity and high kinematic viscosity of the gases.

The small distance between the two pressure tappings enables pressure differences due to buoyancy to be kept low.

Particle Size Meter for Carbon in Luminous Flames. An interrupted parallel beam of ultra-violet light is incident on a region of a luminous flame and the light scattered by the cloud of luminous carbon particles is detected by a photo-multiplier and measuring A.C. amplifier. A small monochromator selects the wavelength of the light incident on the photo-multiplier. The instrument is

operated at an ultra-violet wavelength which is of the same order as the size of the particles and at which thermal radiation from the flame is of low intensity. When wavelength and particle size are comparable, the character of the scattering is strongly dependent on particle size.

Plated-hemisphere and Thermopile Pyrometer. A hemisphere platinum-plated on the inside, allows nearly black-body radiation over all wavelengths to pass through a hole at the top. This is measured by a calibrated thermopile, the true response of which is a few seconds.

Plated Cap and Thermocouple Pyrometer. A fine gauge, butt-welded thermocouple has its junction at the focus of a cap platinum-plated on the inside, the latter being cut from a sphere so that its focus lies at the centre of the circle described by its perimeter. The junction and about $\frac{1}{4}$ inch on either side of it are in contact with the surface when a measurement is made, but the couple is under no special strain.

'Land' Pyrometer for Temperatures above 750°C. A back-silvered, heat-resisting glass hemisphere allows nearly black-body radiation in the visible wavelengths to pass through a small hole at the top, while wavelengths longer than about $2{\cdot}5\mu$ are absorbed by the glass. This prevents reflected radiation from interfering with the heat loss from the surface. A calibrated photoelectric cell, the time response of which is a fraction of the second, placed behind the unsilvered hole will indicate the true temperature of the surface.

Photoelectric Pyrometer for Hot Rolling. This pyrometer has also been built on the principle of the 'Land' instrument. In this design the effective emissivity of a surface is brought close to unity by placing a silvered hemisphere over the hot surface. The radiation is assessed by means of a photo-emissive cell.

'Douglas' Pyrometer for Measurement of Strip. This is a radiation Pyrometer using a photo-emissive cell as its detector, which makes it particularly sensitive to changes in emissivity of stock. It has been designed for the continuous measurement of hot materials (e.g., continuous rolled mild steel strip).

Thermistor Capsule for Measuring the Temperature of Wire. This instrument consists of two beads, whose resistivity is sensitive to temperature changes, embedded inside a small annulus. The annulus is mounted at the exit of the drawing die, in such a way that the drawn wire passes through, but does not touch it. The heat radiated from the wire is picked up by the beads and the emissivity is electrically recorded.

Sequential Scanning Optical Pyrometer. The Sequential Scanner is an optical pyrometer in which the cross section of a steel billet is scanned by a revolving perforated disc. An image of the area uncovered is formed on a photoelectric cell which indicates the variation of temperature across the section.

Method of Weighing a Side-blown Steelmaking Converter. Pictorial illustration of this method is shown. The purpose is to secure a quantitative correlation between operating conditions and refractory lining performance.

The load on one bearing (half the weight of the converter) is by-passed through a specially constructed loadmeter which converts this load into a strain and, at

the same time, into a change of electrical resistance. This is achieved by electrical resistance strain gauges which form a Wheatstone bridge, the out-of-balance condition being calibrated in terms of the actual load of the converter. The weight-changes of the converter at any time are continuously traced on a high-speed recorder. The gauges are protected from severe temperatures by a water-jacket.

Stand 56

STANDARD TELEPHONES AND CABLES Ltd.,

Connaught House, 63, Aldwych, London, W.C.2

Crystals†. A part range including some manufactured from synthetic materials, and demonstrations of piezo-electric phenomena. DEMONSTRATION.

Capacitors†. A range embodying a new type of swaged seam design of case applied to paper and mica capacitors for tropical and super-tropical use. Swaged seams avoid any recesses on these capacitors, consequently settlement of dust or trapping of moisture which would cause leakage paths is eliminated. The further advantage of the design shown is the provision of single hole mounting facilities, the mounting arrangements being located adjacent to the terminal outlets thus avoiding the need for further projections on faces of the capacitor other than that on which the terminals are located.

Pulse Echo Cable Testing Equipment†. For the determination of the impedance uniformity of coaxial cables. DEMONSTRATION.

New Type Miniature Selenium Metal Detector†. For use up to frequencies of 5 Mc/s. and of exceptionally small dimensions ($\frac{1}{4}$ inch diameter by $\frac{1}{8}$ inch length).

New Type E.H.T. Tubular Rectifier†. Incorporating high voltage discs for the first time and thus reducing the overall length for any given voltage Shortly to be in production.

Push Button Attenuator†. A new type of high-frequency attenuator employing interlocking push-button switches is shown for the first time. This type of patented construction considerably reduces the coupling between the pads which are 'active' at any time, and those which are not. The fact that the pads are all similar facilitates manufacture. Cracked-carbon-resistors are used, and contribute towards achieving a very small frequency error. This naturally increases with the amount of attenuation in circuit. During the year that these attenuators have been in production, tests have shown that the performance is considerably better than was at first claimed. For an attenuation not exceeding 50 db. the error at 50 Mc/s. is not greater than a quarter of a decibel.

A New V.H.F. Signal Generator†. This is a high stability generator covering the frequency band 98 to 160 Mc/s. Its output can be varied between 1 μv. and 100 mv. by means of an H_{01} piston attenuator. Provision is made for amplitude modulation by a sine or square wave of any frequency from 20 c/s. to 15 kc/s., the modulation depth is variable from 0 to 90% and is accurately metered.

Modulation distortion and spurious frequency modulation are kept to a minimum. A special model for testing ILS receivers with a frequency coverage of 71 to 125 Mc/s. and 328 to 336 Mc/s. is being developed.

A Practical Application of the Principles of Frequency Synthesis and Analysis†. This is embodied in a V.H.F. communication equipment. In the transmitter a crystal oscillator and multiplier chain are used to produce fourteen frequencies separated by 1 Mc/s., one of which can be selected and mixed in a balanced modulator with the output of another crystal oscillator and multiplier chain arranged to produce frequencies in steps of 200 kc/s. The receiver is a double frequency changing superheterodyne in which the frequency of the first local oscillator can be varied in steps of 1 Mc/s. and that of the second in steps of 200 kc/s. The first I.F. amplifier thus passes all signals within a 1 Mc/s. band and the second I.F. amplifier selects the required signal within this band.

Crystal Triode or Transistor†. Improvements on the crystal triode as demonstrated in 1949 have made possible the construction of a crystal triode which has a current gain as well as a voltage gain. This means that the unit can operate into a low output impedance.

This triode has a current gain of between 1·5 and 2 and requires a low collector voltage.

Reflex Klystron Oscillator†. A copper disc-seal type reflex klystron with external clamped resonator designed to operate in the 6 – 7 cm. wavelength band. It is arranged to work into a 2 in. × 0·67 in. waveguide and has a tapered waveguide section terminating in a standard flange, as part of the resonator. No electrical modification is needed to work into other waveguide sizes.

Coaxial-Line Velocity-Modulated F.M. Oscillator†. This valve is a V.M. oscillator for $\lambda \simeq 6$ cm. of the low voltage type, employing a coaxial-line single-transit system which is electronically tunable by resonator-voltage variations. It is intended for use in F.M. microwave links for which it is important to obtain a high degree of linearity of the modulation characteristics and also as much frequency deviation as possible.

Determination of O_2 Traces in H_2 by Catalyst and Thermistor†. A demonstration of the measurement of oxygen in hydrogen. The operation of the instrument depends on the fact that heat is evolved when oxygen and hydrogen combine in the presence of a cold catalyst. The gas is passed in a continuous stream over the catalyst which has a thermistor at either end of it. The oxygen content is given by the linear deflection of a 100 microammeter which has two ranges corresponding to 0·2% and 2% F.S.D. This instrument has been designed to operate off low pressure hydrogen ($1\frac{1}{2}$ in. water gauge) and consumes less than 2 litres of hydrogen per minute. DEMONSTRATION.

Thermistors†. A range of 'Stantel' thermistors for industrial and research applications including one or two practical demonstrations. DEMONSTRATION.

Stand 57

BRITISH ELECTRICAL & ALLIED INDUSTRIES RESEARCH ASSOCIATION.

5 Wadsworth Road, Greenford, Middlesex

Mr. G. F. Shotter.

Parasitic Forces Existing in A.C. Meters. Research on the bearings of induction watt-hour meters has shown that excessive wear on bearings, apart from normal rotational wear, can arise from parasitic forces existing in the meter.

(*a*) A model is exhibited which illustrates these parasitic forces.

(*b*) The optical method which is used for observing the parasitic forces is shown.

The research was carried out at the Northmet Power Co. (Now Eastern Electricity Board) for the British Electrical & Allied Industries Research Association.

Mr. H. A. Prime and Mr. P. Ravenhill.

Oscillographic Recording of Transient Optical Phenomena. The exhibit demonstrates the method used to investigate the radial distribution of light across a spark channel or gas discharge tube. A rotating mirror is used to sweep an image of a section of a spark or other discharge across a photo-multiplier tube, the output pulse from this tube being amplified and displayed on an oscillograph. The amplitude of the pulse is a measure of the light output from the channel whilst its duration is directly related to the diameter of the channel. DEMONSTRATION.

Stand 58

RESEARCH LABORATORIES OF THE GENERAL ELECTRIC COMPANY, Ltd.

Wembley, Middlesex

Germanium. The devices shown here depend upon the availability of the rare metal germanium. This was previously obtained as a by-product of zinc refining in the United States of America. It has been known for some time that certain British coal contained up to 0·001% of germanium. As a result of a co-operative effort between the G.E.C. Research Laboratories and Messrs. Johnson Matthey Ltd., processes have now been established for the extraction of the element from flue dusts. Specimens of the dust, of the oxide and of the metal are shown.

Crystal Triodes. A design of triode suitable for large scale manufacture is exhibited together with an enlarged model showing constructional details. The design greatly reduces production difficulties associated with controlling the small clearance (about 0·003 inch) between contact points. The two ' catswhiskers ' used in conventional crystal triodes are replaced by two plates separated by a known and accurately controlled spacing.

In order to facilitate the rapid plotting of static characteristics of a large number of samples, a method of test is used whereby the characteristics are displayed on

a cathode-ray tube and then photographed or traced for record purposes. A simplified version of the gear is shown, together with typical characteristics.

Germanium crystal triodes are finding many uses in all electronic applications where small size, low operating voltage and small power consumption are of primary importance. Typical circuits are demonstrated.

Measurement of Magnetic Field by Hall Effect in Germanium. If germanium is prepared with adequate purity, it has a high Hall coefficient, and the Hall effect is large enough to be measured on portable instruments, in magnetic fields of a few hundred gauss or more. A simple self-contained apparatus is shown which measures current and Hall effect in a high purity germanium sample. With a calibrated sample, this apparatus can therefore be used in a simple way to measure and explore magnetic field strength.

A Precision Radio Control System. (This Radio Control System was developed by the Research Laboratories of The General Electric Company Limited on behalf of the Royal Aircraft Establishment, and is exhibited by permission of the Ministry of Supply.)

The apparatus has been designed to control high-speed aircraft under test. Another application is the transmission of accurate data by radio, or two-wire line.

Seven remote servo-units may be independently controlled, one of these may be replaced by a multi-position switch.

The transmitter shaft positions are conveyed as phases relative to a reference phase of a low-frequency tone. These phase-shifted outputs phase modulate eight sub-carriers. The sub-carriers may be conveyed by a two wire line, or used to modulate a high-frequency carrier for radio transmission.

The servo may be classified as Continuously Rotatable Position Control, with three stage torque regulation. The overall accuracy for radio transmission is within $\pm 2\frac{1}{2}^\circ$ in 360°, and for an ideal line $\pm 1\frac{1}{2}^\circ$ in 360°.

Frequency Stabilization by Molecular Resonance. The apparatus illustrates a method by which the frequency of an oscillator may be stabilized. In some cases at low pressures extremely sharp resonance absorptions of electromagnetic waves occur. Ammonia shows strong absorptions for wavelengths in the region of 12 mm.

In the demonstration, an auxiliary scanning oscillator feeds power to a length of waveguide containing ammonia at low pressure, and also to a mixer coupled to the master oscillator. Two pulses are formed, one by an absorption line, the other by the zero beat between the two oscillators. A voltage proportional to the time difference between the two pulses is generated and may be used to bring the frequency of the master oscillator into coincidence with that of the ammonia absorption.

Generation of Very Short Pulses and Transmission Test Set. Very short pulses can be generated most simply by shock-exciting tuned circuits. A positive pulse applied on the grid of a valve shock-excites a tuned circuit connected to the anode. With correct damping, the first negative oscillation is followed by a positive one, sometimes of greater amplitude, and by further oscillations of negligible amplitude. The positive oscillation is applied to the grid of a second valve and shock-excites a tuned circuit connected to the anode, and so on. The tuned circuits are adjusted to resonant frequencies in a series of increasing values and the pulses produced decrease in width from one valve to the next. Very narrow pulses can be

produced easily with high efficiency, for example, pulses of 0·01 microsecond width with an amplitude of about 35 volts in a resistance of 17 ohms.

The generator forms part of a transmission test set for the study of transient response of networks.

Delay Lines and Filters with Bridging Capacities. An ideal delay line must have a constant delay for all frequencies. It is known that mutual inductance improves the phase and delay characteristics up to about 60% of the cut-off frequency. Still greater improvement can be obtained by convenient capacity bridging between every three sections and multiples of three sections. The bridging is done most simply by observing the transient response of the delay line and introducing the correct amount of capacity bridging in order to make the response symmetrical.

Mercury Isotope Lamp. A cold cathode discharge lamp of the Geissler type has been developed, containing the mercury isotope ^{198}Hg as the excited element with an inert gas (Neon or Argon) as carrier. From theoretical considerations lines in the spectrum of ^{198}Hg would be expected to be of very high monochromatic quality, and this expectation is realized in the lamp shown. The form of the tube ensures that the discharge conditions can be accurately specified in terms of the lamp current. The lamp is suitable as a wavelength standard and for any application in which absence of fine structure is an important requirement.

Stand 59
SALFORD ELECTRICAL INSTRUMENTS Ltd.,
Peel Works, Silk Street, Salford 3, Lancs.
Proprietors THE GENERAL ELECTRIC CO. Ltd. of England

Layer Thickness Meter (Figure 1). The instrument measures the thickness of a layer of paint or other protective coating directly, and without damaging the coating in any way.

The layer may be of any non-magnetic material, such as paint, plastic, enamel or non-ferrous metal, whilst the base of the coating may be any magnetic material having a permeability between 600 and 6,000, i.e., any ferrous metal between the magnetic extremes of cast iron and electrical sheet steel.

The layer thickness is read directly from a meter scale calibrated from 0 to 30 thousandths of an inch (0 to 0·75 mm.) and the measurement is accurate to within ± 10%.

Apart from the pilot lamp, which is well under-rated, the instrument contains no components which need periodical replacement, and its reliability is therefore of a very high order indeed.

Figure 1.

General Purpose Illumination Meter. This instrument is admirably suitable for measuring the level of illumination in such places as open yards, workshops, factories, offices, etc.

It consists of two parts, the indicator and the photoelectric cell assembly which are electrically connected by means of a special flexible lead. The indicator is provided with four concentric scales. The top scale, which is 4·4 in. (11·2 cm.) long, indicates to 3 foot candles, the second indicates to 15 foot candles, the third to 30 foot candles and the bottom scale, which is 2·9 in. (7·4 cm.) long, to 150 foot candles. The range change is effected by a small semi-flush switch mounted on the front of the instrument.

The other part of the equipment consists of four square photoelectric cells mounted in a hinged container for setting the cells at any desired angle and also to give protection to the cells when not in use. To enable the plane of the cells to be set at right angles to the source of light a view finder is provided. A spirit level is also included. A screwed bush is provided on the base of the container for fixing this to any standard photographic tripod.

The S.E.I. Exposure Photometer Accessories. *External Supply Adaptor.* This consists of an adaptor containing inside it a 6 v., 6 w. car side-lamp bulb arranged to illuminate a diffusing screen at the upper-end of the adaptor, the illuminated area of which is limited by a diaphragm. This is used instead of the normal 1·1 v. lamp, lamp-housing and dry coil, which are removed and the adaptor screwed in their place. The normal rheostat is then screwed on to the bottom of the adaptor as shown in Figure 4 in the *Osram Bulletin*, the adaptor lead being either plugged in to a 6 v. battery or connected to the 6 v. winding of, say, a mains operated transformer. The internal reference brightness can thus be kept more stable than is possible when using a U2 dry cell. The application is intended for laboratory work or when the instrument is used as a densitometer. It will be appreciated that for this latter application the lamp characteristics and supply on both sides of the 'field' must be the same in order to avoid errors due to mains variations. The adaptor diaphragm is removable and the photometer calibrations can be modified if required (say for laboratory work against a standard lamp) by fitting another diaphragm having a larger or smaller aperture.

Densitometer Supplementary Attachment. This is simply a supplementary lens fitted into the top of a distance tube arranged for clipping to the front of the photometer telescope objective. It is arranged so that an object in contact with the $\frac{1}{8}$ in. aperture at the lower end is in focus. The 'spot' covers an effective area of less than $\frac{1}{100}$ in. diameter under this condition, and the photometer can thus be used as a micro-densitometer either in the hand or, preferably, on the Densitometer Illuminator (described below). By turning a split sleeve, a window in the side of the tube is opened. By arranging an external lamp about two feet away so that the light travels at 45° through this window and the $\frac{1}{8}$ in. end aperture, the reflection density of opaque surfaces can be measured. This allows for both transmission and reflection density measurements being made at will.

Densitometer Illuminator. This is essentially merely a box with an opal window in the top and a 'cradle' on which the photometer rests. It is necessary in practice because the high magnification makes a stationary instrument desirable. The cradle is hinged, and its 'down' position is adjustable to accommodate films,

plates or paper. A 230/6 v. transformer is incorporated inside, together with a 6 v., 6 w. car side-lamp under the opal window. The vertical distance of the bulb from the window is smoothly adjustable for setting the zero balance before the density to be measured is introduced. Sockets from the 6 v. transformer winding are provided for plugging in from the Separate Supply Adaptor referred to above.

The relative accuracy can be within $\pm$ 0·02 times density with practice and the absolute accuracy is similar if a calibrating wedge and plotted correction curve is used. This is necessary only to correct for the slight commercial tolerance on the accuracy of the photometer itself.

Incident Light or Colour Filter Attachment. This is simply a composite filter holder which can be clipped on to the front of the photometer telescope and into which can be fitted either colour filters (glass or gelatine between two glasses) to facilitate matching on coloured surfaces and/or in coloured illumination.

It also takes an 'incident light disc' consisting of two pieces of thin opal glass with a neutral filter between them adjusted to give a back brightness (in foot-lamberts) of one hundredth of the front incident illumination (in foot candles). Thus the photometer can be used for measuring incident illumination or as an incident light meter. The reading is taken on one scale lower than normal to allow for the 100 to 1 absorption factor of the attachment itself (see B.K.S. reprint).

Anti-flare Attachment. This is a diaphragmed tube 3 in. long, dead black inside, which can be clipped on to the front of the telescope objective. It almost entirely eliminates flare and therefore allows of almost strictly objective brightness measurements being made. It is useful for tone reproduction studies, etc.

Link Testing Wattmeter† (Figure 2). This instrument is suitable for measuring the power flowing in A.C. and D.C. circuits without interrupting the circuit.

It consists of two units; a pair of polepieces, one fixed, the other hinged to enable the polepieces to encircle the conductor under test, and a plug-in indicator. The indicator is a spring-controlled dynamometer movement enclosed in a moulded insulated case.

Test leads having H.R.C. fuses and test clips are brought out of the polepiece handle for connecting to the voltage circuit.

The Link Testing Wattmeter is essentially a single phase dynamometer wattmeter with a wound voltage coil and the conductor or cable passing through the polepieces acting as the current coil.

The instruments are calibrated in kilowatts and horsepower, and the following ranges are made.

Figure 2.

Ranges.

0 – 12 kw. (0 – 16 H.P.); 0 – 50 kw. (0 – 66 H.P.); 0 – 100 kw. (0 – 130 H.P.); 0 – 200 kw. (0 – 250 H.P.).

For readings on 3 phase balanced loads the above ranges are multiplied by three. The maximum voltage of all ranges is 250 volts.

Accuracy.

The accuracy is ±5% on D.C. and A.C. from 25 c/s. to 100 c/s.

One or more units can be calibrated with one set of links and Link Testing Ammeter indicators can be made to suit the Link Testing Wattmeter Links.

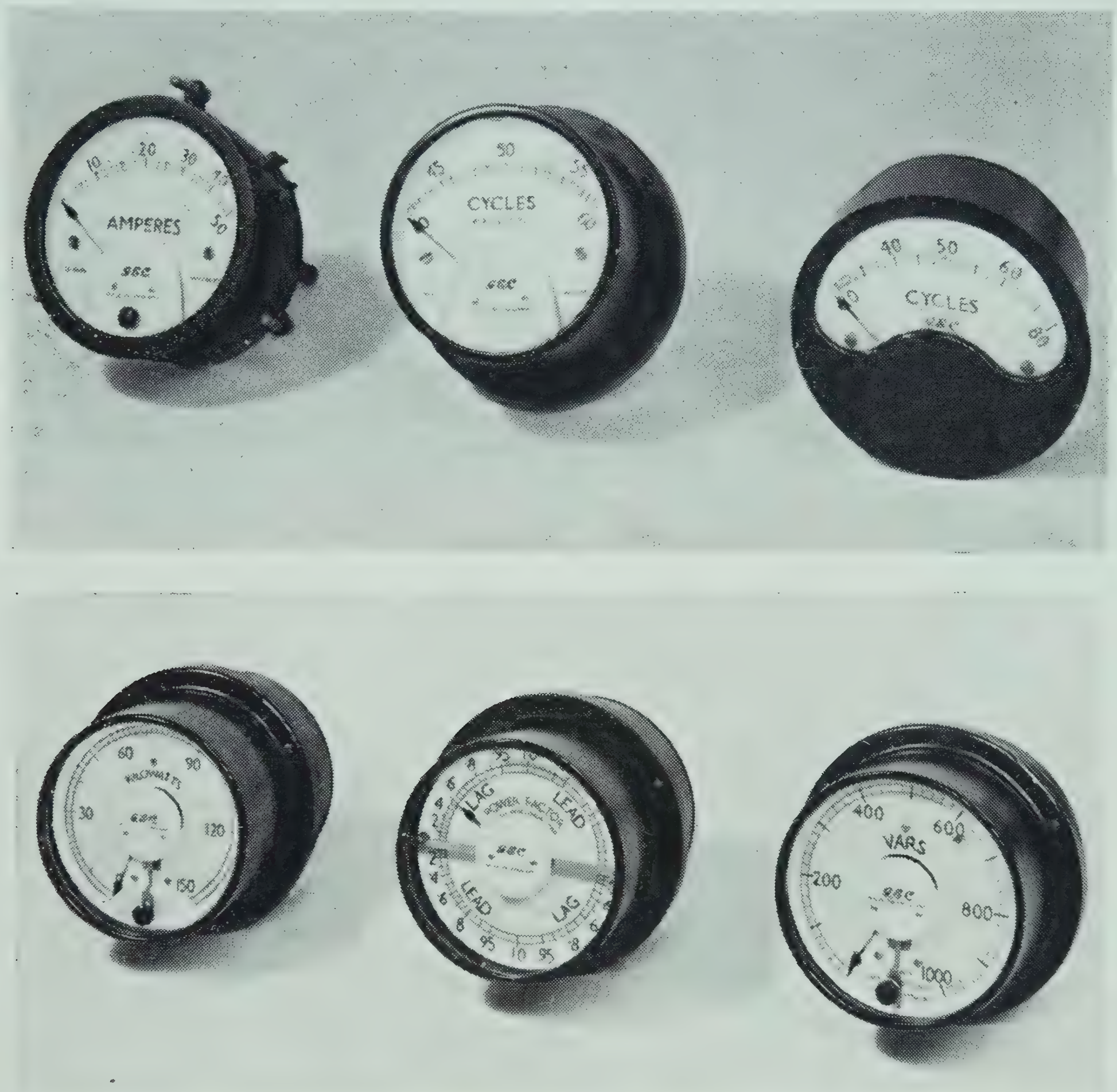


Figure 3.

3½ in. Dial Switchboard Instruments† (Figure 3). These will include the following types:

Moving coil ammeters and voltmeters for direct current.

Moving iron ammeters and varimeters for direct and alternating current.

Moving iron frequency meters.

Moving iron power factor meters for single and polyphase circuits.

Induction type Wattmeters and voltmeters for single and polyphase circuits.

All these instruments are fitted in pressed steel cases, enamelled matt black.

Four styles are available:

1. Projecting Protected Dial.
2. Projecting Open Dial.
3. Flush Protected Dial.
4. Flush Open Dial.

All types comply with B.S. 89/1937 for First Grade accuracy.

Portable Pyrometers using Thermistors† (Figure 4). This instrument is a 6 in. Portable Moving Coil instrument fitted in a waxed Burma teak case. It has an internal bridge circuit and battery. The Thermistor is connected in one arm of the bridge which is brought out to terminals in the wood case. The Thermistor itself is mounted in a ventilated copper sheath.

Temperature ranges up to 300°c. can be made. One great advantage of the Thermistor lies in the fact that leads up to five miles long can be utilized.

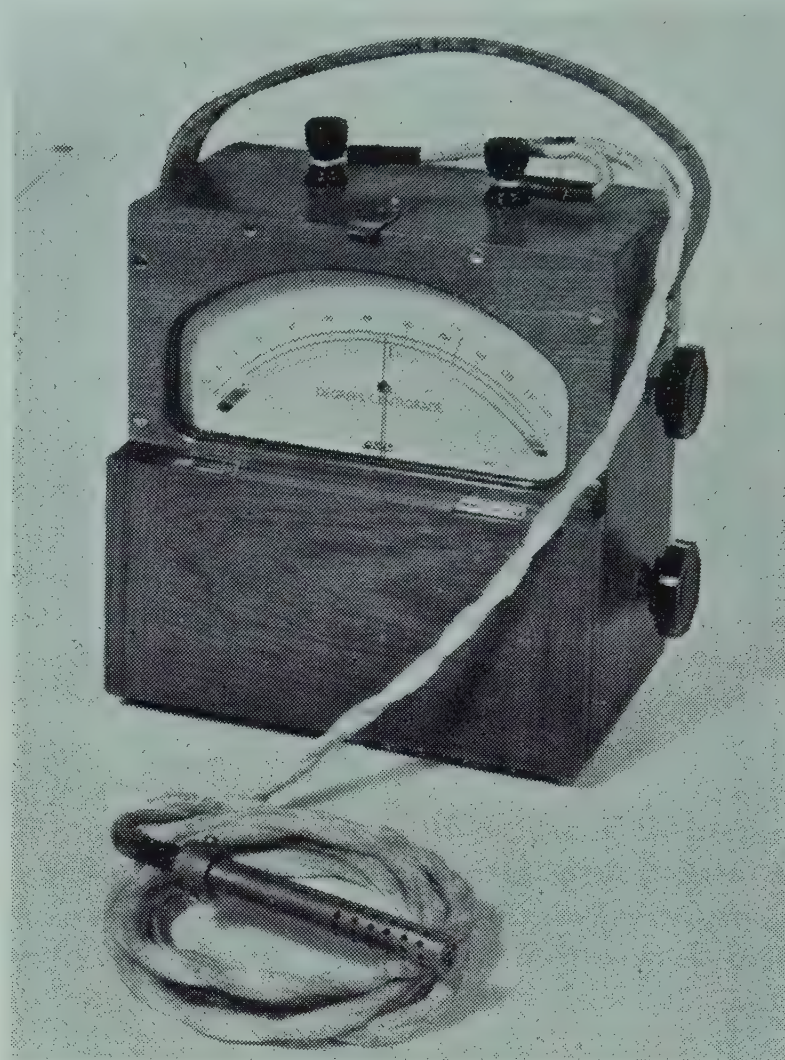


Figure 4.

Powder Core for Power Applications†. This is a new type of magnetic powder core for operating at high flux densities. It is made of a special type of iron powder with comparatively large particles, and gives core permeability values in the range 100/300, and low eddy current at power frequencies. The eddy current loss is much smaller than that of conventional stamping cores, and it is thus suitable for use at the higher power frequencies such as 400, 1,600 and 1,000 c/s. now coming into use for special purposes. Although the permeability is much lower than that of stampings, the core in suitable designs will give a good performance for components which have air gaps, such as chokes, relays, instruments, etc.

Synthetic Sapphires†. This material is now being manufactured on a larger scale in both rod and boule form, and is recommended for industrial applications where its great hardness and wearing properties are of special importance. It is the hardest synthetic material now in use, the hardness only being exceeded by diamond which still has the economic and practical disadvantage of a natural material.

The exhibit shows some of the commercial applications of this synthetic sapphire for balance parts, thread guides, styli and needles, etc.

Quartz Crystals. The exhibit consists of new quartz crystals developed since the last Exhibition, together with oscillators and equipment using quartz crystals or used in their production. These are as follows :

Miniature QA shear mode plates in B7G style holders.

Miniature and standard units in hermetically sealed metal holders with glass terminal seals.

Very low frequency quartz bimorph units for frequencies down to 400 c/s.

A 100 watt standard frequency power supply at 50 c/s., 60 c/s. or 400 c/s. having a frequency accuracy of 20 parts in 10^6, illustrating the use of very low frequency crystals.

G.E.C. low frequency quartz crystal test oscillator for measurement of crystal activity in the frequency range 50 kc/s. to 2·5 Mc/s.

G.E.C. high frequency quartz crystal test oscillator for measurement of crystal activity in the frequency range 2·5 Mc/s. to 15 Mc/s.

Miniature sputtering equipment for vacuum sputtering of gold, silver or similar metals.

Stand 60

CAMBRIDGE INSTRUMENT CO., Ltd.,
13, Grosvenor Place, London, S.W.1

In accordance with previous practice we propose to exhibit only one class of our wide range of products. This year we have selected oscillographs. These instruments are of the electro-magnetic type developed from the original designs of W. Duddell, F.R.S., and are the latest models not previously exhibited.

In addition to the complete outfits we propose to show a number of unit parts illustrating the method of construction and the various switching arrangements. Also a number of old Duddell instruments and photographs of historical interest will be shown, including the original pencil drawings by Duddell to which the first instruments were made.

We also hope to issue a monograph on the history of the development of the Oscillograph with some biographical notes on W. Duddell, F.R.S.

A comprehensive exhibition of all other of our manufactures will be held at our showrooms at the above address.

Six-Element Oscillograph† (see Figure). An instrument for recording up to six phenomena simultaneously on photographic paper or film. It will provide clear, open records for frequencies up to 7,000 c/s. and can be used on a bench or mounted on a trolley as a mobile outfit. The waveforms can be viewed up to the time of making an exposure, and provision is made for photographing transients, which can be positioned on any desired part of the record. The whole apparatus is operated from mains voltage at supply frequency.

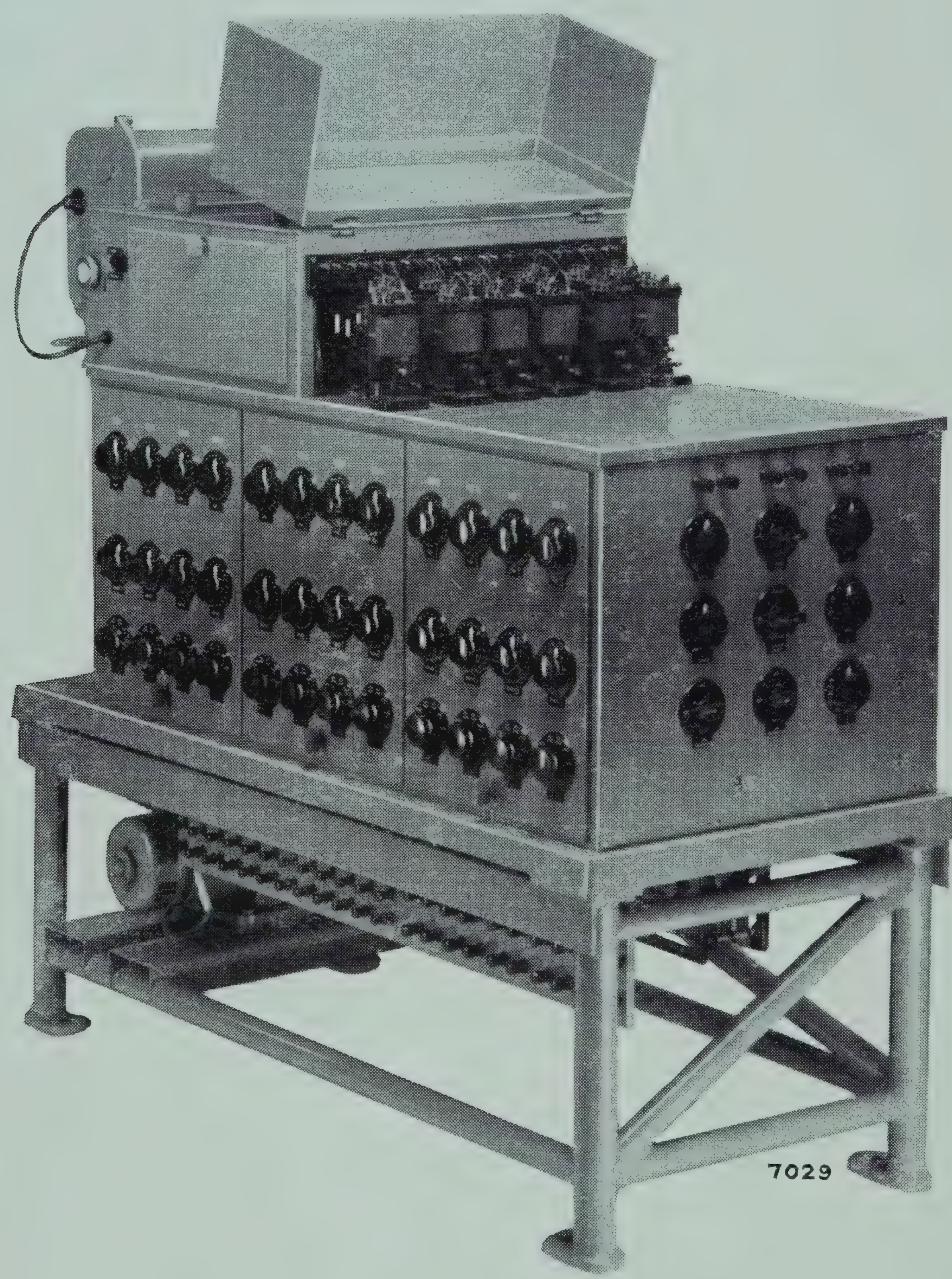
The light source for the six records is a single 8 volt tubular lamp, the light passing through six adjustable slit masks. In front of the slits are six spherical strip lenses, each of which focuses an image of the lamp filament on to its respective vibrator mirror, the return beams being focused by further lenses on to a cylindrical lens and thence on the photographic surface in the camera.

Each vibrator comprises a bifilar loop carrying an aluminized mirror, tensioned to a predetermined natural frequency and mounted between the poles of a permanent magnet. The system is critically damped by insertion in a specially constructed leakproof oil bath. Low frequency, high, and extra-high frequency vibrators are all interchangeable without re-alignment of the optical system. By adding field terminals to the connecting board, provision can be made for one or more watt vibrators. The amplitude of each vibrator can be controlled by means of continuously variable resistances which may be connected in series or in parallel.

A neon lamp energized by a self-starting contact-driven 100 c/s. tuning fork provides time markings on the record at 10 millisecond intervals. The various

controls are accommodated on a panel conveniently placed at the side of the Oscillograph.

The camera may be of the Drum type, giving high speed records up to 12 metres per second, and carrying $\frac{1}{2}$ metre of film on paper 120 mm. wide ; or a Continuous Paper Camera may be used for slower speed work up to 2 metres per second, carrying film or paper of the same width in lengths up to 100 feet. A shutter between the cylindrical lens and the camera can be set by hand and released



electrically, by a press key or by a commutator revolving with the camera drum, enabling the beginning of the record to be correlated with the beginning of the paper or film. A safety shutter on the drum camera is automatically opened when the drum is in position but operates to close the aperture when the camera is removed.

In the Continuous Paper Camera the film or paper is brought into motion by a magnetic clutch. The paper will reach a speed of 2 metres per second in less than 100 milliseconds, and is fed into a detachable cassette, enabling the exposed portion to be removed for developing without removing the camera.

The camera, commutator, and rotating mirrors for visual observation of the

waveforms are driven by a variable speed A.C. motor through three cone pulleys which give speed ratios of 1 : 3, 1 : 1 and 3 : 1.

All rectifiers, condensers, relays and the time marker, etc. are mounted on a removable chassis, thus giving easy access for servicing. DEMONSTRATION.

12-Element Oscillograph†. This is designed on similar lines to the 6-element instrument, but is provided with 12 vibrator systems, the light source being 4 8-volt lamps — each lamp covering three vibrators. The photographic film or paper for the records is 300 mm. wide. Visual mirrors are not provided, but a calibrating screen with a hinged lid is fitted into the top panel. Vibrator controls are supplied for calibrating each vibrator for voltages up to 240 and current to 10 amperes. Transient contacts are provided which will handle 0·2 amp. at 100 v. D.C. ; 2·0 amp. at 24 v. D.C., and 2·0 amp. at 240 A.C., 50 c/s. This Oscillograph is not available as a bench instrument and can only be supplied mounted on a stand. DEMONSTRATION.

12-Element Portable Oscillograph†. This Duddell-type 12-element instrument has been designed primarily for the investigation of strain and vibration problems in aircraft during flight, but has many applications in other fields where a multi-channel portable recorder is required. It is robust and simple to operate, all unessential adjustments being eliminated. The overall dimensions are 18 in. × 10 in. × 8 in. and the weight approximately 60 lb. Twelve interchangeable elements are fitted, each completely sealed, having the following characteristics :

Resistance : 1·7 ohms.
Sensitivity in the Oscillograph : 0·8 mm/ma.
Resonant frequency in air : 3,000 c/s.
Maximum recording frequency for linear response : 1,000 c/s.
Maximum safe current : 200 ma.

The elements may be thermostatically controlled to within a degree or so of 30°C. even when the external temperature falls as low as – 20°C. The thermostat requires a current of about 3 amp. at 12 v.

The camera accommodates 100 feet of film or paper 120 mm. wide, driven at selected speeds between 2 and 50 inches per second. Any length of record may be exposed at one time, controllable either manually or automatically, between 6 inches and 10 feet. Push-button or remote control can be employed. A rheostat enables the brilliance of the recording lamps to be adjusted to suit the recording speeds used, enabling a complete roll of records at various speeds and frequencies to be correctly exposed and processed as a whole. Each exposure is automatically numbered on the record and shown on a counter dial. The records are fed into a removable cassette, the closing of which cuts the paper (or film) so that records of any length can be immediately removed for developing. An indicator shows the amount of unexposed paper still available.

For visual observation the light-beams may be directed to a viewing screen at the top of the instrument, and by slightly oscillating a mirror below the screen the waveform may be observed.

Apart from accessory equipment such as amplifiers required for particular investigations, the Oscillograph is operated entirely from a 12 v. D.C. supply. The maximum current taken is about 10 amperes.

Stand 61

THE EDISON SWAN ELECTRIC COMPANY Ltd.,

155, Charing Cross Road, London, W.C.2

Microfilm Reader Model 11A†. This microfilm reader is a development of the Model 11 reader exhibited in the 1949 exhibition. Its particular features are :

(*a*) Direct magnification from film to screen up to 20 times.

(*b*) Automatic coupling of the spool winding and film gate opening mechanisms to give positive prevention of film scratching during movement of the film through the carrier.

(*c*) A front projection system combining the advantages of a film gate at the most convenient position just above table level, a screen inset into the body of the instrument and thus protected from stray light, and the minimizing of temperature rise of the film. The instrument provides a high contrast image which can be read comfortably in a normally illuminated room.

(*d*) Film on spools or in strip form may be employed with equal ease. The instrument accepts 35 mm. or 16 mm. film either perforated or unperforated. An alternative film gate accepts and manipulates film fiches.

(*e*) The reader may also be used to project an image with greater enlargement on to an external screen and may be used to make permanent records by photographic enlargement. DEMONSTRATION.

High Speed Pen Recorder and Amplifier†. A new eight-channel moving-coil recorder of very robust construction with a flat frequency response from zero to above 90 c/s. Direct ink writing is provided with a pen radius of 10 cm. and a maximum deflection of 2·4 cm. peak to peak. High linearity and critical damping are important features. It is shown in operation with an amplifier suitable for electro-encephalography. DEMONSTRATION.

Gamma Radiation Monitor, Type 1030C†. This monitor is a portable battery operated radiation monitor for bench use and is entirely self-contained. It indicates integrated dose up to 0·125 roentgens on a 2½ in. meter. The unit consists of a condenser ionization chamber directly connected to the grid of a miniature electrometer valve.

Photoelectric Absorptiometer†. An instrument for routine determinations which is entirely self-contained and mains operated. High sensitivity and stability are obtained and direct reading is provided on a robust milliammeter which replaces the usual delicate galvanometer. DEMONSTRATION.

Timer†. A simple electronic pre-set timer for specified periods. DEMONSTRATION.

Demonstration Panels of Valves at Work. Modern radio valves are shown in several specialized electronic circuits to illustrate the exact function of these circuits to those less familiar with electronic technique. DEMONSTRATION.

New Types of Thermionic Valves†. This display shows a number of new types of thermionic valves developed during the past twelve months.

Stand 62

HILGER & WATTS Ltd.—WATTS DIVISION,

48, Addington Square, London, S.E.5

Quartz Fibre Microbalance. The instrument exhibited was designed* and constructed by the National Research Council of Canada, Chalk River Laboratory, Ontario, Canada. It is exhibited by the kind permission of the National Research Council of Canada and of the Ministry of Supply, Atomic Energy Research Establishment, Harwell.

The sensitivity of this balance depends on the torsion of a horizontal 25 micron quartz fibre. This fibre is fused to a balance beam constructed of 200 micron quartz fibres. The null position of the beam is established by setting to coincidence, by means of the torsion head, the optical images of the two ends of a horizontal 10 micron index fibre. The sensitivity of the setting represents a weighing sensitivity of 10^{-8} gm. The maximum weight difference measurable by torsion is two milligrams. The maximum total load is about 1 gramme.

The torsion head is adapted from a Watts surveyor's theodolite. A projection from the transit axis carries the torsion fibre. The rotation of the torsion head is limited to $+$ 3 turns and, for convenience of counting, centesimal theodolite graduations have been used, read by vernier to 0·01 grade (32·4 seconds of arc).

Thermal convection is minimized in the beam housing by making this of a massive, airtight, duralumin block within which the quartz suspension operates in a narrow cavity. The scale pans are shielded by airtight cups which can be raised and lowered for loading the balance.

An improved model of the instrument is being designed which will incorporate a glass circle in the torsion head divided into 1,000 parts and both the graduations and the index fibre will be observed by optical projection on a ground glass screen.

The instrument is used mainly in connection with microchemistry, particularly of radioactive substances. It is expected that further application will be found in biophysical and other fields.

The Amerada Gauge†. The Amerada Gauge is a bottom hole pressure gauge of small diameter, used for the accurate determination of pressures and temperatures in oil and gas-condensate reservoirs. The pressure element is a separate inter-changeable unit and can be supplied in a variety of specified ranges, enabling both absolute and comparative pressures to be measured to a high degree of sensitivity.

The active element in the gauge is a helical Bourdon tube, the open end of which is fixed and the sealed end attached directly to a recording stylus. The interior of the Bourdon tube is subjected to the pressure in the well and the resulting rotation of the free end is recorded by the stylus on a coated metal chart. The chart is carried in the interior of a removable cylindrical chart holder driven by a removable clock. The recording mechanism of the gauge is so designed that ordinary wear and tear have no effect upon the accuracy of the instrument.

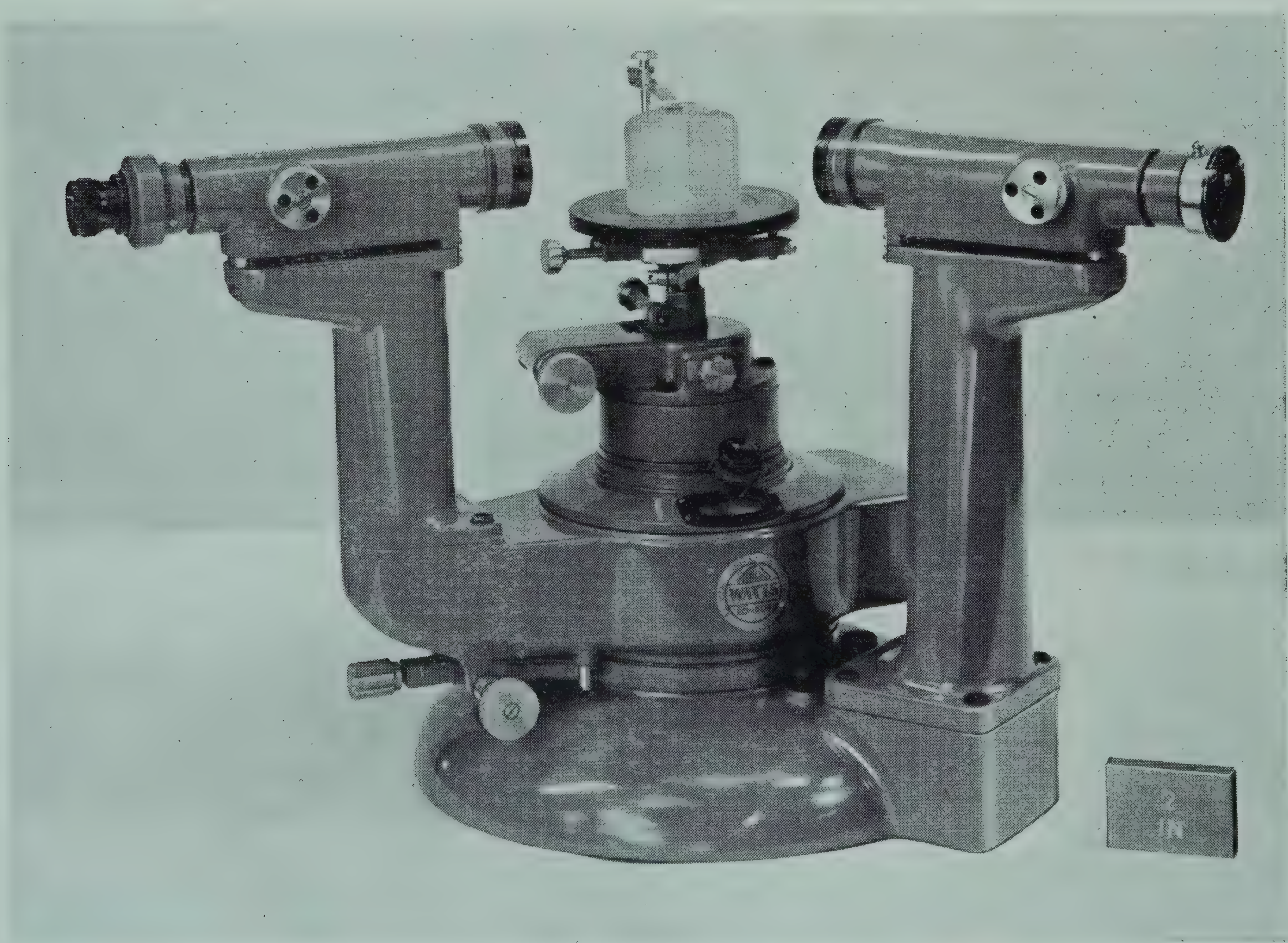
Pressure elements can be supplied in practically any desired range from a minimum of 300 lb/in^2 to a maximum of 10,000 lb/in^2.

*A previous form of this instrument has been described by Kirk, Gullberg, Craig and Boyer, *Analytical Chemistry*, 1947, **19**, 427. A full description of the present instrument is being published by Dr. H. Carmichael, N.R.C., Chalk River Laboratory, Canada.

The accuracy of the gauge is 0·25% of full scale value. To attain this, it is necessary to calibrate the gauge at the temperature at which it is to be used or to apply temperature correction to a room temperature calibration. Each pressure element is individually calibrated at room temperature and at any specified elevated temperature.

The Amerada Gauge may be converted into a recording thermometer by substituting a temperature element for the pressure element. This temperature element is of the vapour tension type. The exterior of the bulb is exposed to the fluid in the well and the vapour pressure of the volatile fluid inside is transmitted to the interior of the Bourdon tube and is recorded by the stylus on the metal coated chart.

Standard Spectrometer. This is a re-designed Spectrometer on which opposite verniers read directly to half a minute. It completes the range of four new Spectrometers which have been made to cover all requirements in Research, Industry and Education. As on the other Spectrometers, equal accuracy of setting is obtainable on the table movement and on the telescope movement since the same circle is read for both. The instrument is very robust and has a range of accessories — polarizer and analyser, camera attachment, etc.



Standard Spectrometer.

Chart Measuring Microscope†. This was originally designed for measuring the metal coated recording charts from the Amerada Gauge. It is a small measuring machine with a chart table which has measured motion in two perpendicular directions observed by a microscope. A setting of the time interval on the charts

is made on the longitudinal motion of the table and the gauge reading of pressure is obtained on the lateral motion. The longitudinal motion is measured to within an accuracy of 0·25 mm. against an arbitrary scale and the lateral movement, controlled by a micrometer, is measured directly to 0·02 mm.

The range of longitudinal movement is 125 mm. and the scale is divided into 100 parts, figured every 10. Its position is adjustable for zero setting.

The transverse carriage for the lateral motion runs on roller bearings and is operated by a micrometer screw with a 50 mm. range of movement. It has a pitch of 1 mm. and each division on the drum equals 0·02 mm. Accuracy of reading is within $\pm$ 0·01 mm.

The microscope can be adjusted on its pillar. It is fitted with screw focusing eyepiece inclined at 45° and a cross-wire graticule with rotational adjustment. A small lamp is provided.

Provision is made for accurate location of the chart on its mounting plate.

Stand 63

HILGER & WATTS Ltd. — HILGER DIVISION,

98, St. Pancras Way, Camden Road, London, N.W.1

New Compact 3 Metre Grating Spectrograph†. A new design of spectrograph in which compactness has been secured by means of a 'folded' optical path. The system employed is effectively an Eagle mounting in which a plane mirror has been interposed between the grating and the rest of the optical system. Slit, plate and grating are at one end of the instrument and faced by a surface reflecting mirror. As a result a 3 metre radius grating spectrograph takes up about the same space as a 1½ metre instrument. Interlinked adjustments, actuated by an electric motor under push-button control, enable any range of wavelengths to be selected and set by referring to a long wavelength scale associated with the camera. The push-button controls allow of two alternative speeds of the setting motor for preliminary and final setting.

The instrument is made in two designs, one of which has hand settings for the plate holder 'racking' motion and one (which is shown) has a very elaborate and convenient set of controls for the plate holder 'racking' and exposure, all operated from a centrally situated console or control desk.

Plateholder movement can be continuous at a preselected speed, or intermittent with preselected distances between spectra. The spark source and an electromagnetic shutter are controlled by two electrical programme timers which can be set to give desired durations of pre-spark and exposure times.

The plateholder movement switches are so arranged that, once the appropriate conditions have been preselected, a touch on a button sets in train a complete sequence of pre-spark, exposure, and plate racking, each phase of which is indicated to the operator by tell-tale coloured lights on the control board. On reaching the limit of movement of the plateholder the preset selector button is released and a warning light illuminated.

The spectrograph can be supported on a laboratory bench or mounted on special metal cabinets which provide accommodation for the control board and also for a spark source unit.

Either photographic plates (which are bent to approximately half the full curvature in their holders) or standard cine film in a specially designed holder,

can be used. The plate holder used is 20 in. in length but it can be used with two 10 in. plates end to end. In the film holders the film is held in the correct focal curve by suction.

A ruled diffraction grating of 14,400 lines per inch is used.

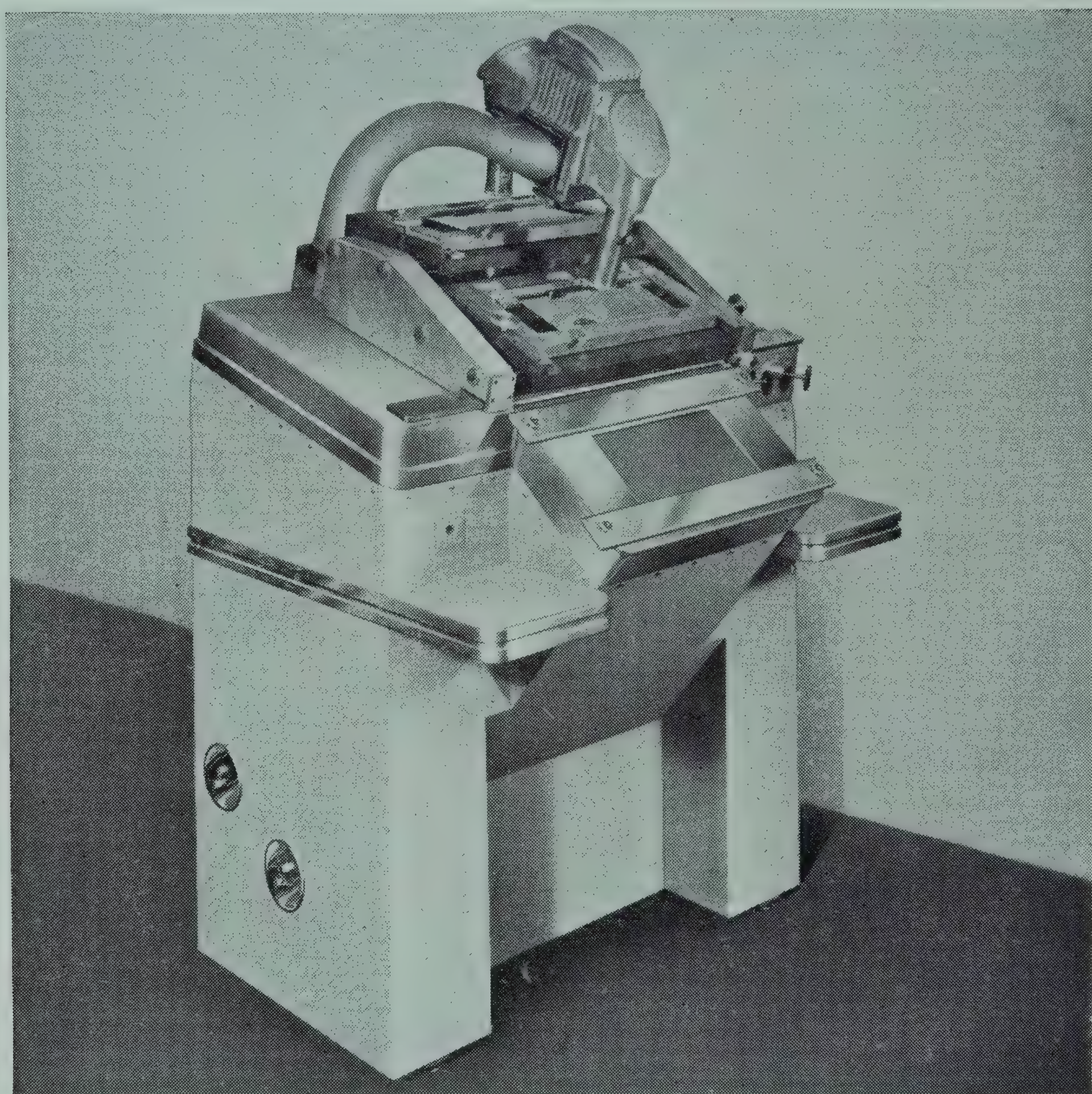


Figure 1.

New Projection Spectrum Comparator† (Figure 1). In some spectrochemical laboratories carrying out a large volume of qualitative analysis the examination and comparison of large numbers of spectrum photographs poses difficult problems owing to the fatigue suffered by operators using eyepiece spectrum comparators for several hours at a stretch. As a means of reducing this fatigue the projection spectrum comparator has been designed.

The two spectrum plates to be compared are mounted on two separate mechanical stages fitted to a common movable framework which can be traversed horizontally from side to side. Matched projection lenses produce images, after reflection in a mirror at the base of the comparator casing, on a conveniently sloping glass screen whereon the two spectra are seen in very close juxtaposition. Since both the observer's eyes are used to examine the spectra, fatigue is very largely eliminated.

The massive carriage containing the mechanical stages for the plates is supported on specially designed ball bearings and a slight touch only is required to set it in motion. A screw clamp arrests it at any desired position on giving a slight turn to a milled knob. A fine screw motion adjusts one plate in relation to the other for matching up the spectra, but once set the spectra remain in their correct rela-

tionship when the main carriage is traversed. Each stage has its own rack and pinion adjustment normal to the dispersion of the spectra.

The lenses normally supplied give a magnification of $\times 20$ but interchange able paired lenses to give magnifications of $\times 15$ or $\times 10$ can be supplied.

The relative intensities of the two images can be controlled to assist comparison of spectrum line intensities. Plates of sizes up to 12 in. $\times$ $5\frac{1}{4}$ in. can be fitted to the plate stages, which are similar in design to those used on the Hilger Non-Recording Microphotometer. The light source common to both projection systems is a 12 volt, 150 watt, 'solid source', projection lamp, run from a built-in transformer.

The area of the projection screen can be reduced by means of two adjustable, horizontal metal shutter blades so that the operator's view is restricted to the two spectra being compared and the eye is not distracted by other spectra in the field of view.

Designed to stand on the floor it has a metal cabinet base provided with shelves for note pads or books and the screen is at a suitable height for a seated observer.

New Design of Infra-Red Spectrometer and Monochromator†. In this spectrometer the normal form of Wadsworth prism-mirror constant deviation system has been modified by adding a second plane mirror so that a considerable improvement in resolving power and definition is obtained throughout the spectrum and the full aperture is maintained. The instrument's mechanical details have also been modified in several respects. A metal cover which encloses the whole optical system has been shaped to hold a magnifying lens for the wavelength scale, and electrical illumination for the scale is built in, with a small transformer for providing the necessary low voltage for the scale lamp. A new type of wavelength drum is used, in which the index is advanced by a helix on the main drum engaging with a rack on the index. This assists interchange of the drums, since the engraved sleeves are not mechanically engaged with the index.

As in the earlier Hilger Infra-Red Spectrometer the dispersing prisms can be readily interchanged, together with the wavelength calibrated sleeves appropriate to them, so that dispersions and ranges of transmission suited to the work in hand can be selected. Calibrations cover the ultra-violet, visible and infra-red ranges of the spectrum. Materials include quartz, glass, rocksalt, potassium bromide, lithium fluoride and fluorite. Prisms have an angle of 60°, length of face 54 mm., height 45 mm. The aluminized collimator and focusing mirrors have apertures 75 mm. diameter and 330 mm. focal length.

Symmetrical slits with stainless steel jaws adjusted to 0·0025 mm. in width are fitted and the exit slit is arranged for the attachment of a Schwarz Thermopile.

New Semi-cylindrical X-ray Cameras†. These are primarily intended for use with the H.R.X. diffraction unit. A set of three has diameters of 60, 114·6 and 190 mm., and the exposed portion of the film in each case is 70 mm. wide. They are provided with mechanism for oscillating block specimens and for rotating wire or fibre specimens. Each has a height adjustment.

Raman Source and Control Unit†. The source has been shown before in a prototype form and has been described in *J. Sci. Instrum.*, 1949, **26,** 299. A cylindrical, water jacketed, metal box of relatively small size, whitened internally with a magnesium oxide film contains four specially designed mercury vapour lamps arranged around a glass central portion in which there are concentric cylinders

forming first a waterjacket, secondly a cylindrical liquid filter and thirdly a central space to accommodate the vertical specimen tube.

The specimen tubes are straight vertical tubes with end plates fused to their lower ends. No more than 6 ml. of liquid are required to fill each tube to the required height. They can be rapidly interchanged in the source unit without any disturbance to the set-up.

The lamps emit the characteristic low pressure spectrum of mercury at great intensity with only a comparatively low background intensity in the region between 4,358 and 4,911A.

A control unit gives a number of selected loadings with total wattage dissipation by the four lamps of approximately 1,000, 1,350 and 1,700 watts. Higher loadings may be used for very short periods without loss of intensity of line in relation to background but with some shortening of the life of the lamps. The intensity of the blue 4,358A. line bears a linear relationship to lamp current.

The Raman spectra excited are of high intensity and the spectra of such substances as meta-, ortho- and para- xylene, ethyl-benzene, toluene and styrene have been fully exposed in 60 seconds with the lamps run at 1,750 watts (after 1,350 hours continuous running) on a spectrograph with a camera aperture of f/5·7 on an Ilford Zenith (backed) plate.

Two-camera, Two-prism Glass Spectrograph†. This instrument is especially suitable for photographing spectra of very low intensity such as are yielded by fluorescence or by the Raman effect. An important feature is the provision of two alternative cameras, so mounted that either can be interchanged with the other by the rotation of a mount through a small angle without disturbing the set-up of the spectrograph or of its accessories. One camera has an aperture of f/1·5 with a mean inverse dispersion on the plate of 66A. per mm.; the other has an aperture of f/5·6 with a mean inverse dispersion of 16A. per mm. Both cameras take quarter-plates ($3\frac{1}{4}$ in × $4\frac{1}{4}$ in.) and are provided with the usual arrangements for racking the plate to take a number of spectra.

The glass prisms used in this instrument are unusually large, 86 mm. high × 130 mm. and 164 mm. length of face respectively.

New Model Spekker Fluorimeter† (Figure 2). This modification of the Spekker Absorptiometer is designed for the measurement of the fluorescence of solutions and hence for the chemical analysis of their fluorescent components. The light source employed is a Mercury Vapour Discharge lamp whose ultra-violet radiation is filtered, usually by Wood's glass filter. On one side of the lamp the usual compensator head and photocell receives the light, on the other the light after

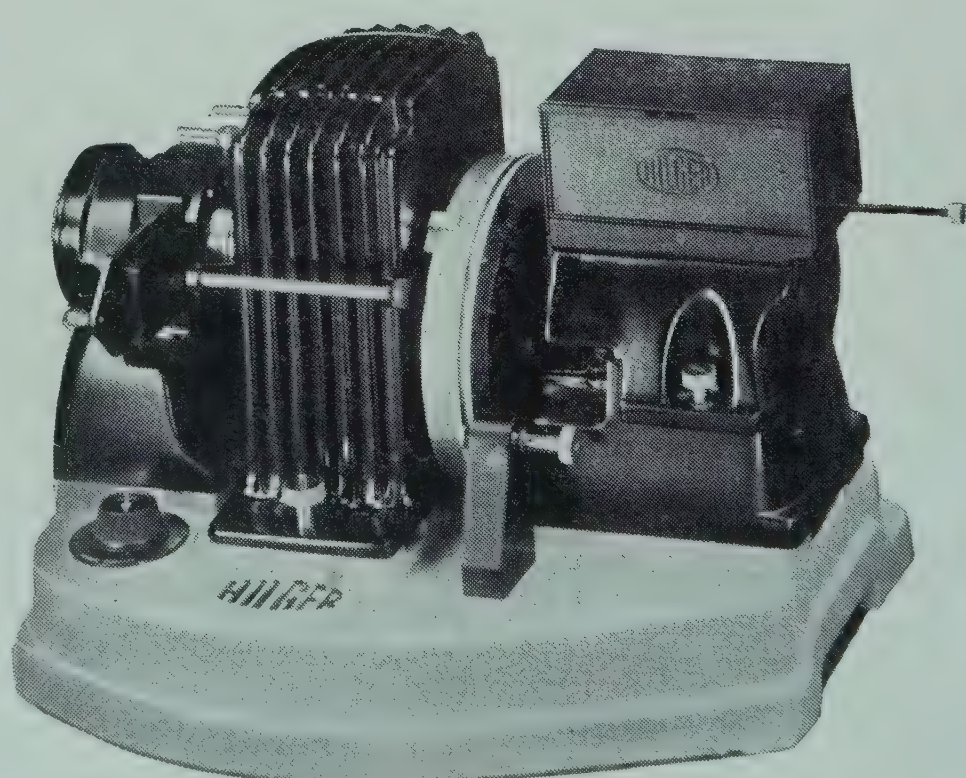


Figure 2.

passing through the measuring aperture of the absorptiometer is reflected vertically upwards through the base of the cell containing the solution to be examined. In the solution it excites fluorescence which passes horizontally through the cell walls to fall upon two photocells, situated one on each side of the cell. These cells are connected, in opposition to the compensator cell, to a sensitive, reflecting galvanometer which indicates their balance by a null reading.

By substituting two photocells on the measuring side of the instrument for the one formerly used and by making them of much larger sensitive area the sensitivity of the instrument has been increased to some six times that of its forerunners.

As there is a risk of reducing the sensitivity of the cells if they are flooded with bright light a special shutter arrangement with which they can be protected has been introduced into this instrument and has been interlocked with the cell compartment cover so that it can only be opened when the safety shutters are properly in place.

Narrower cells in this instrument reduce the amount of solution required and enable the photocells to be brought closer to the source of fluorescence.

The measuring device, which consists of a rotatable cam-shaped opaque disc has two calibrated scales, one is of optical densities (log I'/I) and is mainly used for absorptiometry ; the other is of transmissions (T) and is of most use for fluorimetry. Both scales are long (about 16 in. developed length) so that they are open and easily read with accuracy.

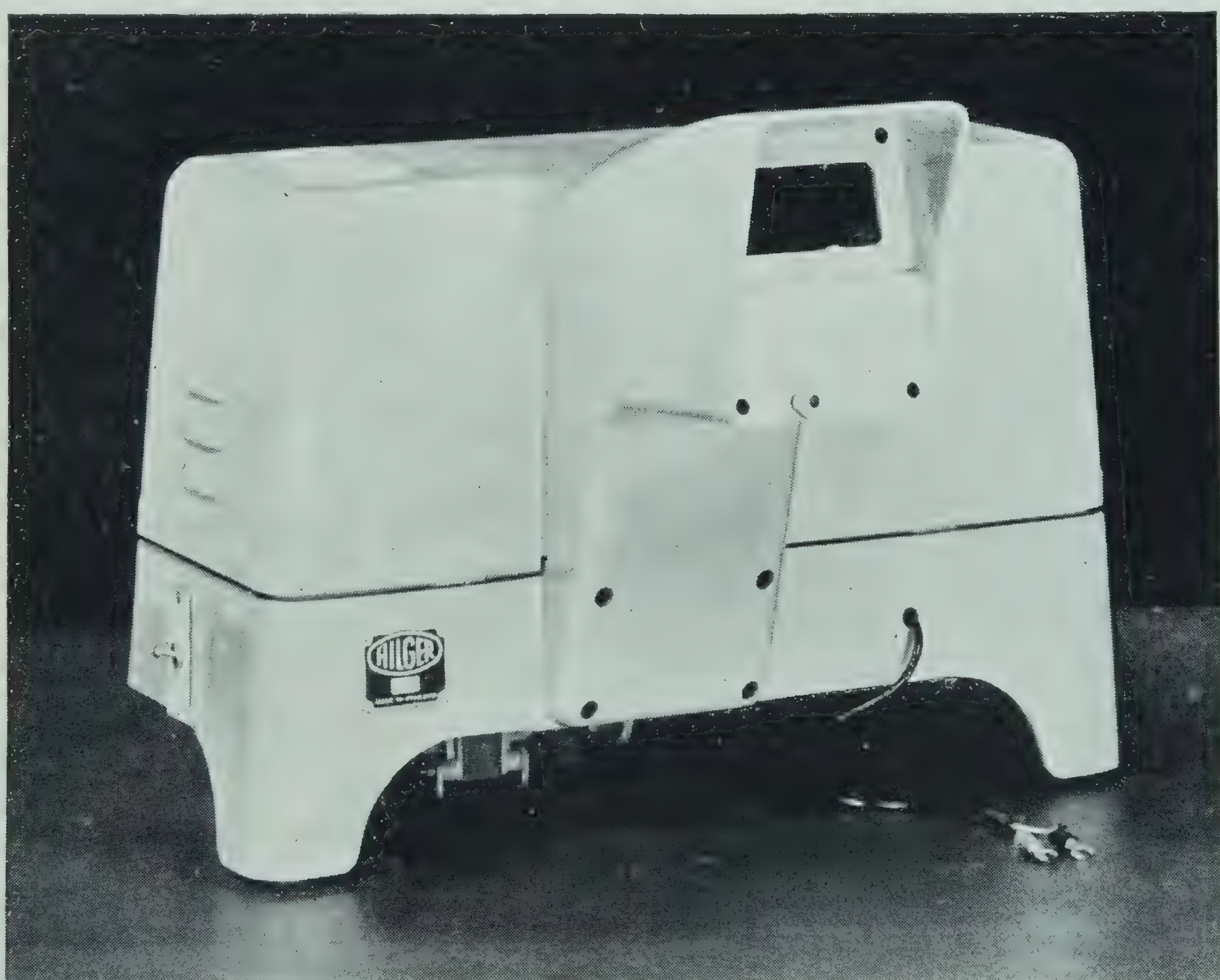


Figure 3.

New Hilger Galvoscale† (Figure 3). The use of reflecting galvanometers with the conventional lamp and scale device is wasteful of space and subject to vibration troubles. These are important factors in a works laboratory, and their avoidance is worth while in any laboratory.

The Hilger Galvoscale (shown with the Spekker Fluorimeter) has been completely redesigned and is now completely enclosed for protection of the optical system. With it the observed deflections are equivalent to those obtained with the galvanometer 2 metres from a conventional type of lamp and scale. The light follows a folded path and extra magnification is given by an auxiliary projection lens which reprojects the image formed of the scale by the first lens and mirror of the galvanometer.

The galvanometer is carried on an anti-vibration mounting and the scale is remarkably steady, even when there is some vibration. The standard instrument is fitted with a Tinsley galvanometer.

New Photoelectric Scanning Unit for Spectrographs. This apparatus, which has been adapted from a device developed in the Billingham research laboratories of I.C.I., is intended for the direct recording of variations in spectrum intensities. It can be attached to a Hilger Medium Quartz Spectrograph of type E498 whose flat focal field is particularly favourable for the use of such an accessory.

Within a casing, attached directly in place of the usual camera back of the spectrograph, is a slit and photo-multiplier traversed at a selected uniform speed along the spectrum by a synchronous electric motor. A small mirror reflects the radiation passed through the slit on to the cathode of the photo-multiplier and the whole assembly is automatically orientated to suit the change in angular direction of the light path of the spectrograph. The rate of scanning can be adjusted by selecting suitable gears between the motor shaft and the lead screw ; the four speeds provided are 1, 2, 4 or 8 minutes per centimetre of traverse and the total scanning range in wavelengths is from 2,000 to 8,000 A. A hand-wheel is provided for setting the multiplier at any desired position, indicated by a counter, and for returning it when it has accomplished the full traverse. A micro-switch at the end of the scanning path acts as a safety-switch by cutting out the motor. Interval marks on the record are provided by a linearly spaced square-toothed rack in the housing which operates a micro-switch in the circuit of an interval marking light.

A separate recorder unit consists of a reflecting galvanometer and a drum camera mounted on a hollow base some four feet in length, containing the batteries for the photo-multiplier and the necessary control gear and transformers for the motor and recording lamps. On top of this base, at one end, is a reflecting galvanometer (Tinsley) to which the multiplier is directly connected, on an anti-vibration mount similar to that used in our Galvoscale, together with a lamp and projector system projecting a slit of light on to the cylindrical lens in the front of the drum camera at the further end of the base. The camera motor and gearing gives alternative speeds of 1 revolution in 24 minutes or 1 revolution in 6 minutes. If the fastest scanning speed is used with the slow camera speed a complete record of the spectrum from 2,000 to 8,000A. will be contained in one drum revolution. An indicator on the drum camera shows how far the drum has turned. The camera is daylight-loading and a screen shades the recording slot from excessive top light so that records can be taken in a dimly lit room — complete darkness is not required. An interval marking lamp is operated from the contact rack in the scanner already referred to above.

The equipment has been successfully used for recording absorption spectra in the ultra-violet, for which purpose a hot cathode hydrogen discharge lamp run under controlled conditions is a suitable source.

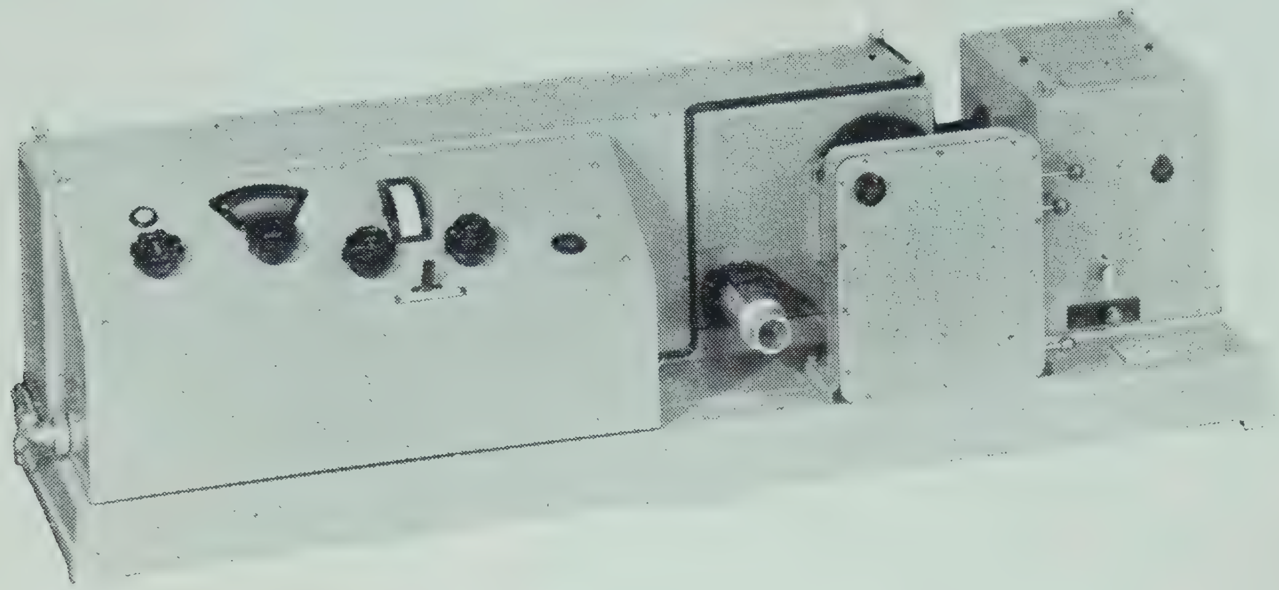


Figure 4.

New Attachments to the Hilger Uvispek Spectrophotometer (Figure 4). *Flame Attachment.* This device can be mounted in place of the usual illumination housing of the Uvispek Spectrophotometer. It enables lines in the flame spectra of elements to be selected by means of the monochromator system of the Uvispek Spectrophotometer and it is a special convenience of this instrument that a glass prism can be substituted for the usual quartz one and greater dispersion obtained in the visible region where sensitive lines in the flame spectra of some elements (particularly the alkali metals) are to be found. The intensities of the spectrum lines reaching the photocells are then measured on the measuring unit of the Uvispek.

Diffuse Reflection Attachment. An attachment to the Uvispek spectrophotometer that enables the user to measure diffuse reflectivity at different wavelengths.

Fluorimeter Attachment. This attachment enables the user to make use of the sensitive photocell and measurement units of the Uvispek for measurements of the output of fluorescent light from solutions. (It does not employ the monochromator section of the instrument.) The solution in the cell is illuminated with filtered ultra-violet light and the fluorescence emitted perpendicularly to the direction of the incident radiation falls upon one of the photocells whose output is measured by the usual Uvispek measuring unit.

New Flow-through Preparative Cell for Tiselius Electrophoresis Apparatus†. In the preparation of fractions in the Tiselius type of Electrophoresis apparatus, separable cells of large capacity from which the liquid can be pipetted have been employed hitherto. They require, however, relatively large aperture optical systems and there is some loss of time in dismounting the cells and removing the contents. This cell consists of a single U-tube with two rectangular section limbs, demountable for cleaning, connected with the electrode vessels by ground joints. At the sides of each limb are short ground conical connectors fitting complementary cone joints on long capillary tubes clipped to the supporting frame so as to project above the water in the water bath. A fifth tube enters the horizontal bottom of the U-tube. The boundary is established by using the side tubes which, after the space between them has become uniform, are used to with-

draw the product. Fresh solution is introduced through the bottom tube. By reversing the electrophoretic current each limb can be used in turn. The quantity prepared is not limited by the capacity of the cell sections so the need for very large optical systems is avoided.

Abbe Refractometer modified for Opaque Substances†. The new Hilger Abbe refractometer introduced about a year ago has several improvements in mechanical design, and in its present form a simple modification of the prism box enabling opaque specimens to be tested by reflected instead of transmitted light has been added.

Schwarz Thermopiles†. New types of these very sensitive thermopiles, whose times of response are measured in fractions of a second, will be shown.

Stand 64

CINEMA-TELEVISION LIMITED,

Worsley Bridge Road, Lower Sydenham, London, S.E.26

Universal Valve Tester†. This instrument is designed to display on a cathode-ray tube a family of (anode volt, anode current) curves for any receiving type valve. Curves for eleven different grid voltages are shown simultaneously, and a calibration pattern is displayed enabling the voltage and current characteristics to be checked. Nine different valve sockets are provided, connections to the electrodes being made by means of a push button switch selector board. These switches are so arranged that any number of electrodes may be connected to one supply, but no two supplies can be connected to one electrode. The anode voltage sweeps from 0 to 200 v. or 0 to 400 v., whilst the anode current range is from 5 ma. full scale to 1 amp. full scale. The eleven grid voltage steps are from 0·5 v. to 10 v. in 5 ranges, i.e., the eleven curves are spaced in 0·5 v., 1 v., 2·5 v., 5 v., or 10 v. steps, each range commencing at zero volts. The heater voltage supply is variable over the range 1 v. to 300 v. at 0 to 0·5 amp. or 0 to 5 amp. A number of other variable supplies are available for use on visual or static tests. Special protection circuits ensure that the maximum anode current and screen dissipation for the valve under test is not exceeded. DEMONSTRATION.

R.C. Oscillator and Automatic Frequency Monitor† (Figure 1). This instrument will provide an accurate variable frequency from 10 c/s. to 100 kc/s. with a variable output from 0 to 30 v. r.m.s. An output attenuator (600 ohms) is also provided covering the range 0 to 110 db. in 1 db. steps. The high accuracy is obtained by the use of a built-in automatic frequency monitor. This consists of a crystal oscillator controlling an electronic gate, and five decade units. The gate can be opened for periods of 0·1, 1 or 10 seconds, during which time the individual cycles from the R-C oscillator are recorded by the decade units. By this means the frequency of the oscillator is very accurately measured, and is indicated on the five panel meters each scaled 0 to 9. When recording for 0·1 or 1 second, the monitor will record the frequency and after a convenient 'reading time' will return all dial readings to zero, and recount. This operation continues automatically. When counting over a period of 10 seconds, the frequency remains displayed until reset by hand. The overall accuracy of the R-C oscillator is

within $\pm$ 0·005% with possible errors of $\pm$ 10, $\pm$1 or $\pm$ 0·1 c/s., according to the frequency timing interval used. DEMONSTRATION.

Figure 2.

Figure 1.

Self and Mutual Inductance Bridge† (Figure 2). This Bridge has been designed with a view to providing a high accuracy in low inductance measurements. The inductance range is from 0·03 μH. (3×10^{-8}H.) to 30 mH. (3×10^{-2}H.) the first scale reading being 0·001 μH. (10^{-9}H.) whilst the resistance range is from 0·003 ohms (3×10^{-3} ohms) to 3000 ohms (3×10^{3} ohms). This wide range is covered in 12 overlapping steps. The Bridge employs a four-terminal network, thus eliminating the inductance of the leads and contact resistance. It also enables either self or mutual inductance to be measured without any complex circuit changes. Indication of balance is given on a centre zero meter operating as a phase-sensitive detector, thereby making the resistance and inductance controls virtually independent. The operating frequency of the Bridge is 1592 c/s., giving an angular frequency of 10,000, and the accuracy is to within $\pm$ 1% on all ranges. DEMONSTRATION.

Wide Range Capacitance Bridge†. This Bridge has been designed to meet the demand for an accurate instrument capable of low capacitance measurement. The capacitance range is from 0·1 pF. (10^{-13}F.) to 100 μF (10^{-4}F.), the first scale reading being 0·005 pF. (5×10^{-15}F) whilst the resistance range is calibrated from 1 ohm to 30,000 megohms (3×10^{10} ohms). This wide range is covered in 18 overlapping steps. The Bridge is double screened, thus eliminating the capacitance of the leads and contact resistance. It also enables the measurement of direct admittance between two points A and B to be made without being affected by admittance from either A or B to a third point C. The operating frequency of the bridge is 1,592 c/s. giving an angular frequency of 10,000, and 'balance' is indicated by a 'magic eye' tuning indicator. DEMONSTRATION.

Square Wave Generator and Pulse Unit†. The main application of this instrument is in checking the frequency response of amplifiers of all types. The generator will provide a square wave 1:1 mark–space ratio, top and bottom flat $\pm$ 1%, over the frequency range 5 c/s. to 150 kc/s. Coarse and fine frequency controls are provided, covering the range in 8 steps. The output voltage is measured on a calibrated dial, and covers the range :

15 mv. to 5 v. in 100 ohm.	Time of rise	0·015 μsec.
5 v. to 15 v. in 300 ohm.	,, ,,	0·05 ,,
15 v. to 50 v. in 1000 ohm.	,, ,,	0·15 ,,

The Pulse Unit consists of four delay lines of different lengths, which may be selected by a switch. When the generator is used in conjunction with this unit, a pulse output waveform is obtained, the pulses being 0·05, 0·1, 0·2 or 0·3 microseconds at amplitudes up to 5v.

Stabilized High Voltage Power Pack†. In order that consistent results may be obtained with Geiger-Müller tubes, it is essential that the supply potential should be subject to the minimum variation. This Power Pack will supply a voltage in the range 500 v. to 2000 v. calibrated with a stabilization ratio of greater than 100. The maximum output current is 5 ma. and the internal impedance is less than 2000 ohms at all frequencies.

Microsecond Counter Chronometer† (Figure 3). Designed to meet the ever increasing demand for accurate measurement of short time intervals, this chronometer will measure time in the range 1 microsecond to 1 second in steps of 1 microsecond with an accuracy to within $\pm$ 0·01%, $\pm$ 1 microsecond. It consists essentially of a crystal oscillator, electronic gate and six decades. Initially the oscillator is operating, the gate is shut and all the decades are set to zero. On receipt of a start pulse (10 to 40 v. positive) the gate opens and the decades begin to count individual cycles of the oscillator. When a stop pulse (10 to 40 v. positive) is received the gate is shut, leaving on the panel meters a direct indication of the number of cycles counted between the two pulses. The standard frequency is 1 Mc/s. giving a range 1 μ sec. to 1 sec., and a frequency of 100 kc/s. is also

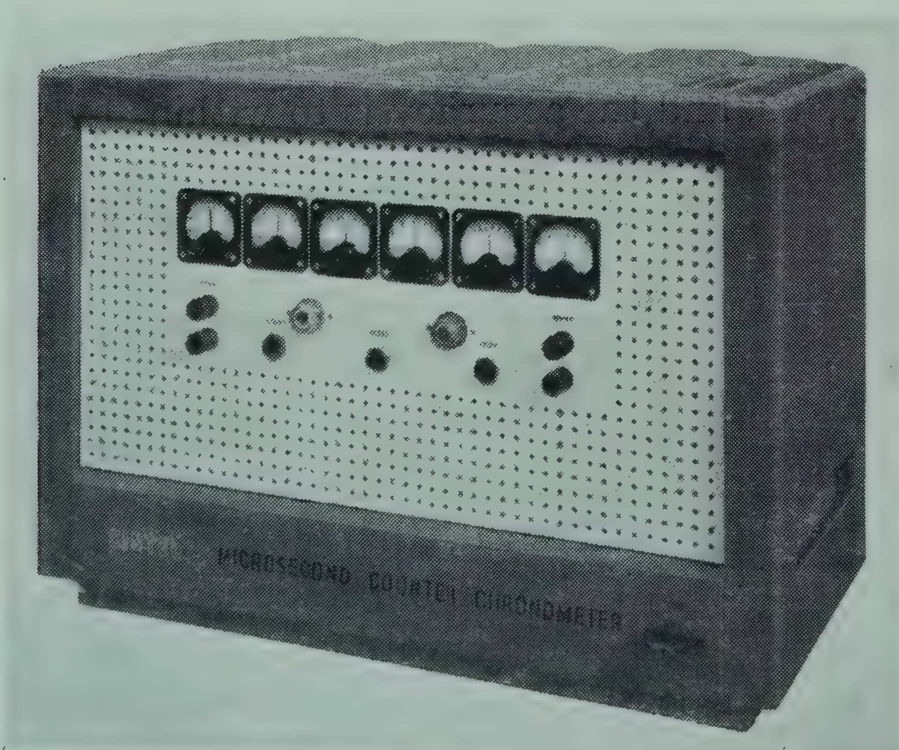


Figure 3.

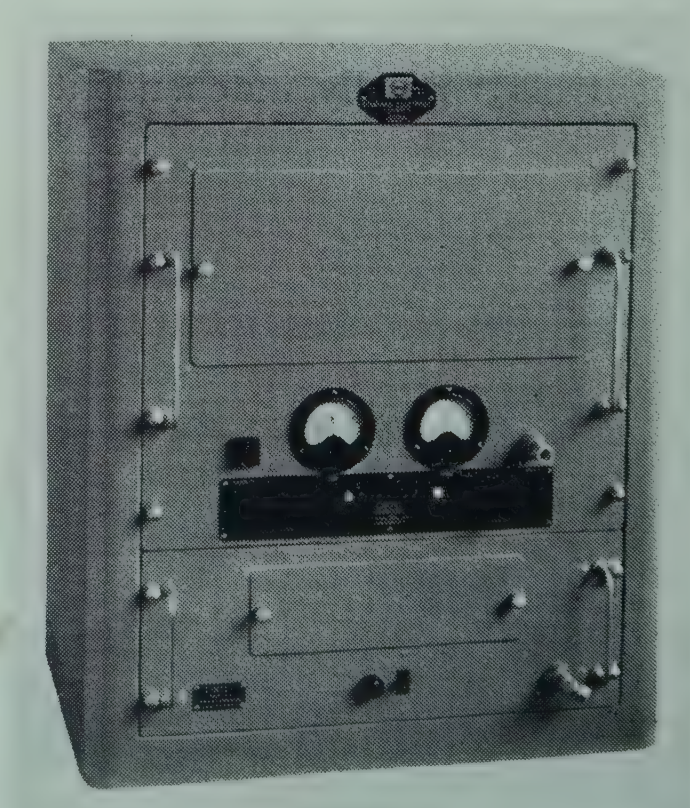


Figure 4.

provided giving the range 10 μ sec. to 10 sec. Other frequencies are available to special order, and provision is made for the use of an external frequency.

Standard Electronic Counter Type UC2A† (Figure 4). This electronic scaler counting at a maximum rate of 30,000 per minute is seen recording cosmic radiation detected by a Geiger-Müller tube. The equipment consists of two hard valve scale-of-ten counting circuits and a mechanical counter and the resolving time is less than 4 microseconds. Stabilized Power supplies are used and a Start Stop switch is provided to render the counting circuits inoperative. DEMONSTRATION.

Geiger-Müller Tubes†. A selection of tubes are shown for cosmic, gamma and beta ray counting. The cosmic-ray and gamma-ray tubes vary in size from 65·0 cm. $\times$ 3·7 cm. to 11·5 cm. $\times$ 2·2 cm. A new type of filling has been developed which enables tubes to be used down to – 20°c. The beta-ray counters have the low temperature filling and a window thickness of 35 mg. per sq. cm.

Photoelectric and Multiplier Cells†. 'Cintel' cells are all of the emission type as distinct from the barrier-layer or selenium cells. They are manufactured in two ranges, Standard and Special. The former includes all types suitable for soundhead equipment, whilst the latter includes some 60 different types which cover almost every known application. The cells differ in three essential properties:

(*i*) Spectral sensitivity.
(*ii*) Vacuum or gas filled.
(*iii*) Size and projected cathode area.

Multiplier cells are available in three types and are designed to give an amplification factor of between 1000 and 5000.

A representative selection is shown.

Stand 65
MARCONI INSTRUMENTS Ltd.,
St. Albans, Hertfordshire

Moisture Meter, Type TF.933†. This portable instrument, awarded the Royal Agricultural Society's Silver Medal (Shrewsbury 1949) in the New Instruments class, is designed for the rapid and accurate estimation of the moisture content of a wide range of hygroscopic materials — particularly those of organic origin — under field or laboratory conditions. The test cell, which is of the compression type, is suitable not only for granular or fibrous substances, such as cereals or tobacco, but can also be used with specimens taking the form of sheets or boards.

An important characteristic of the test-cell is the application of great pressure to the tested specimen; this serves to bring the material to a uniform state, eliminate packing errors and minimize the effect of uneven moisture distribution. In the case of the commoner cereals and cigarette tobacco the instrument is direct reading, but for more specialized substances chart tables are used.

The range extends from near-saturation to below air-dry values, but is dependent somewhat upon the substance itself and the temperature. For the greatest accuracy — whether by oven methods or by electrical means — an average should be taken on account of the comparatively random nature of moisture distribution. A basic accuracy against a specified standard method of at least 0·5% moisture

content may be expected, with a repeatability well within 0·2%. Under adverse conditions individual deviations up to 1% may be encountered.

The standard model takes its supply from internal dry batteries, but these can be replaced by an A.C. mains unit available as an accessory.

Electronic Counter, Type TF.922/1† (Figure 1). The counter is a direct-reading six-decade instrument which may be used either for counting a million periodic or random impulses at rates up to one million per second, or for the measurement of time intervals up to one second in steps of a microsecond; it comprises a 1 Mc/s. crystal-controlled oscillator, an electronic switch and a series of decade counters with visual indicators, the reading appearing in illuminated figures.

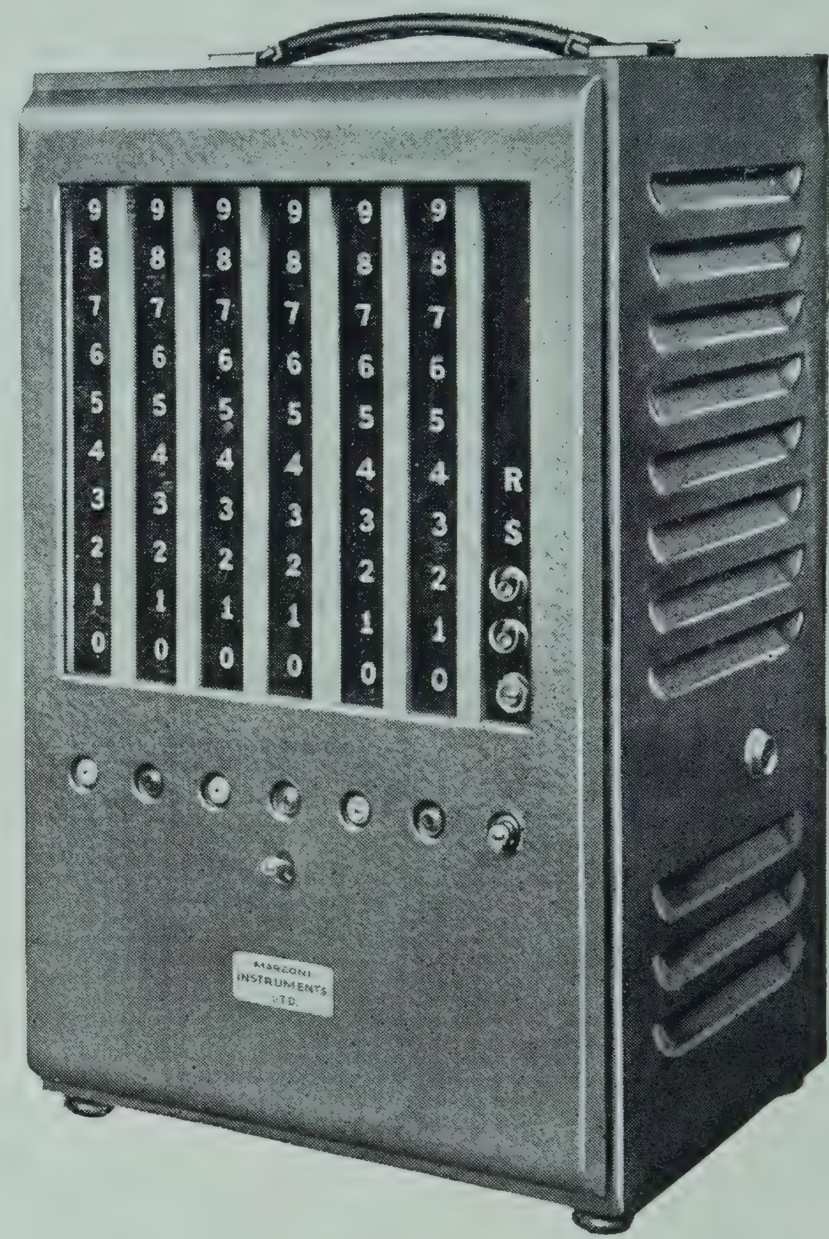


Figure 1.
Electronic Counter Type TF.922.

An important design feature is the employment of scale-of-two counter trains – with their essential reliability and positive action – which retain the material advantage of direct decade reading. Normally a train of binary counters would have a natural count of sixteen, but the application of feedback from third to second and from fourth to third stages advances the count so that the complete cycle is achieved in ten impulses. Miniature neon lamps are used to illuminate the figures.

When employed as a timer, the starting and stopping pulses operate the electronic switch so that the counter circuits determine the number of cycles of the oscillator occurring in the interval. When used as a straight counter the oscillator is stopped and the impulses are applied to the counter train via the electronic switch.

The A.C. power pack, comprising fuses, mains transformer, fullwave valve rectifier and smoothing, is housed in the bottom of the case beneath the oscillator and counter units.

Level Recorder Type TF. 946†. This high velocity level recorder is designed for inputs having frequencies between 50 c/s. and 15 kc/s. – as its name implies, however, the *level* of the input is recorded, not the input waveform. Among the applications for which the instrument is suitable is the recording of audio-frequency response characteristics of filter networks, amplifiers and loudspeakers.

The recorder is essentially a self-balancing potentiometer in which the recording stylus is mechanically coupled to a resistive potentiometer controlling the input, the drive being by means of a double-acting magnetic clutch in the form of a ferrous tongue between the rotating pole-pieces of an electromagnet excited by

two drive valves in antiphase. The motion of the stylus is solely at right angles to the motion of the waxed paper recording strip and no arc distortion is introduced.

The maximum amplitude of recording is 50 mm. and the maximum velocity of the stylus is 60 cm/sec., giving a response to changes in level at rates up to 900 db/sec.; chart paper speeds of 0·25 cm/sec. or 1 cm/sec. may be selected at will and a press-button-operated event-marking stylus is provided which operates on the edge of the chart.

The recorder is for operation from 50 c/s. A.C. supply mains and the whole of the equipment — amplifier, recording unit and power pack — is housed in a single compact case.

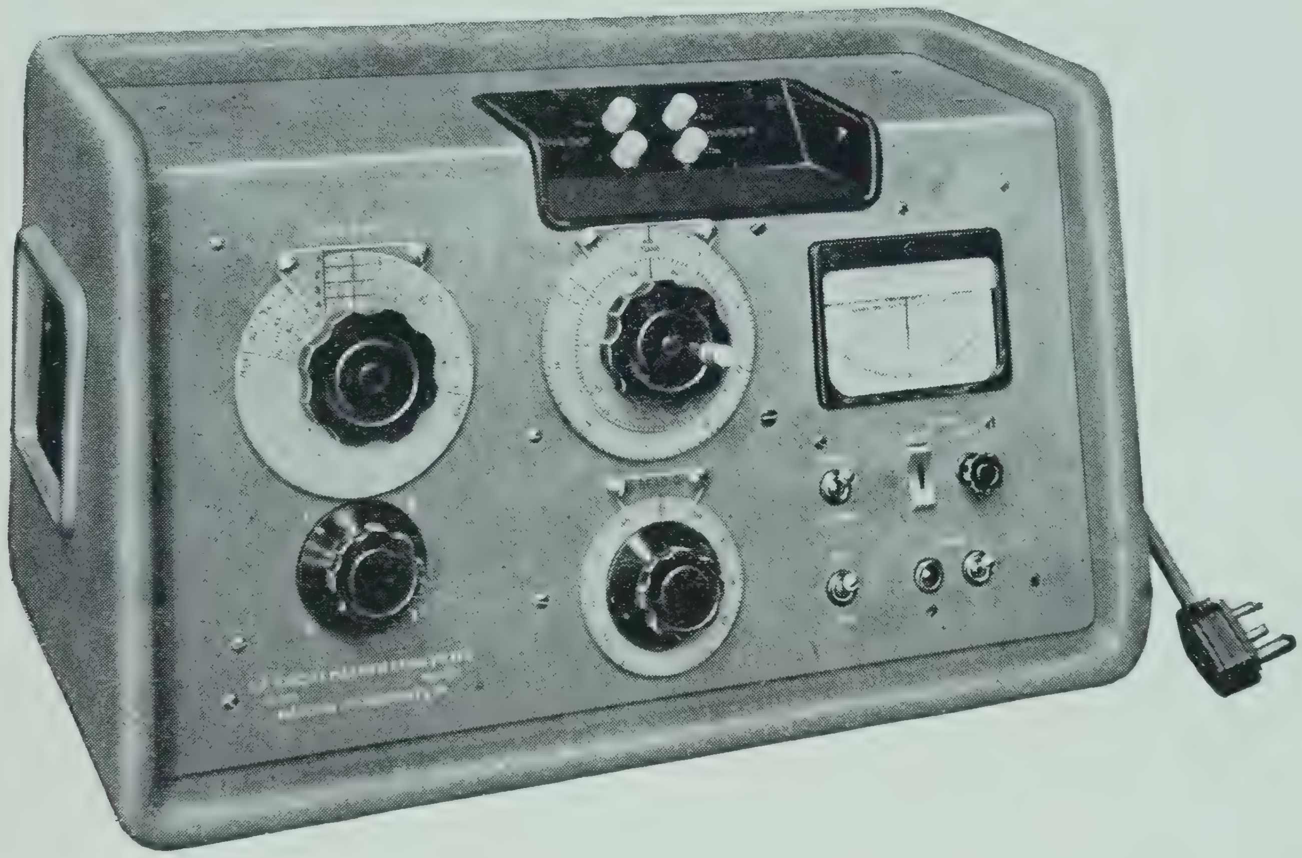


Figure 2. Circuit Magnification Meter (H.F.) Type TF.886.

Circuit Magnification Meter Type TF. 886† (Figure 2). Primarily a direct-reading Q meter for use in the frequency range 15 to 170 Mc/s.; a feature of the design is the use of only one meter for the simultaneous monitoring of the injected and developed E.M.F.'s by a balance method which renders the oscillator level non-critical. The essential controls consist of an oscillator frequency dial, a slow-motion tuning dial for the test circuit and a Q dial.

The oscillator comprises a single valve which covers the frequency range in four bands, the tuning condenser calibrated in frequency. The test circuit includes a very low inductance into which the output from the oscillator is injected in series with the coil under test; an internal low-loss condenser with a capacitance calibration is used to tune this circuit. Terminals are provided for checking capacitors.

The injected voltage and the voltage developed across the tuned circuit at resonance are rectified by independent diode systems and applied in opposition to a bridge-connected D.C. amplifier with centre-zero balance indicator; balance is obtained by adjusting a variable resistance calibrated in Q.

The instrument is housed in a cast aluminium case with an inclined panel. Heavy terminals for test components are mounted adjacent to the horizontal top deck. The mains lead is stored in a recess behind one of the flush-mounted handles.

Television Sweep Generator Type TF.923†. In conjunction with a suitable cathode-ray oscilloscope, the generator is used for the visual checking and alignment of television or F.M. receivers, aerials and feeders. The main radio-frequency carrier output embraces television bands in the range 40 to 190 Mc/s., while the intermediate-frequency bands are 5 to 15 Mc/s. and 20 to 30 Mc/s.; the video-frequency band is 0 to 10 Mc/s. The generator is A.C. mains operated and all the above bands may be frequency-swept at the frequency of the supply; frequency sweeping, which is of continuously variable width, is obtained by means of a vibrating capacitor driven by a concentric permanent magnet moving coil system.

An X-axis deflecting voltage of variable phase, synchronized with the frequency sweep, is available for application to the oscilloscope; in addition, a blanking circuit is included which produces a zero reference line when required.

In operation, with the X-axis drive applied to the X amplifier of the oscilloscope and with the frequency-swept output of the generator applied to the Y-axis via the system under test, the frequency response characteristic of the latter is displayed on the tube.

F.M. Receiver Tester Type TF. 913†. This A.C. mains operated instrument combines a crystal-standardized C.W., F.M. and A.M. signal generator with an audio-frequency power meter in a single assembly of notably small size and weight. The carrier range is 21 to 168 Mc/s. in three bands of 21–42, 42–84 and 84–168 Mc/s. The output, which has high and low limits of 0·1 V. and 1 μV., may be frequency modulated up to a maximum deviation of 75 kc/s. on the low frequency band, 150 kc/s. on the medium-band or 300 kc/s. on the high-frequency band. Amplitude modulation is available to a nominal depth of 30% over the complete range. The internal modulation frequency is 1,000 c/s. and external modulation may be substituted.

A separate crystal-controlled oscillator provides ten checking points on each band and the beats may be heard either via the receiver under test or by head telephones plugged into the crystal oscillator circuit.

The output power meter, which is for the measurement of the audio-frequency output of the receiver under test, has three power ranges extending up to 1 watt and a choice of four input impedances between 3 ohms and 600 ohms.

A full-wave rectifier provides all D.C. H.T. requirements; in the case of the reactor and radio-frequency oscillator valves the H.T. is neon-stabilized and heaters with smoothed D.C. L.T. supplied by a full-wave metal rectifier. The primary of the transformer is tapped for 200–250 volts and adequate radio-frequency filtering is introduced into the A.C. input circuit.

H.F. Field Intensity Meter Type TF. 930† (Figure 3). A portable instrument complete with adjustable dipole aerial and 30 ft. transmission line for radio-frequency field-strength measurements in the range 18 to 125 Mc/s., the power supply being taken from external batteries. Measurements on both frequency-modulated and amplitude-modulated transmitters may be made during actual modulation, the field intensity measurement range varying with frequency in relation to the effective height of the aerial; at 18 Mc/s. signal intensities between about 10 μV. and 100 mV. per metre may be determined, while at 125 Mc/s. the intensity range is approximately from 100 μV. to 2 V. per metre.

In operation the gain of the receiver section is standardized against an internal calibrating oscillator of known level. Next, the attenuation and output is noted while receiving the wanted signal. The derivation of the field intensity from the measurement data involves only one process of multiplication. To embrace

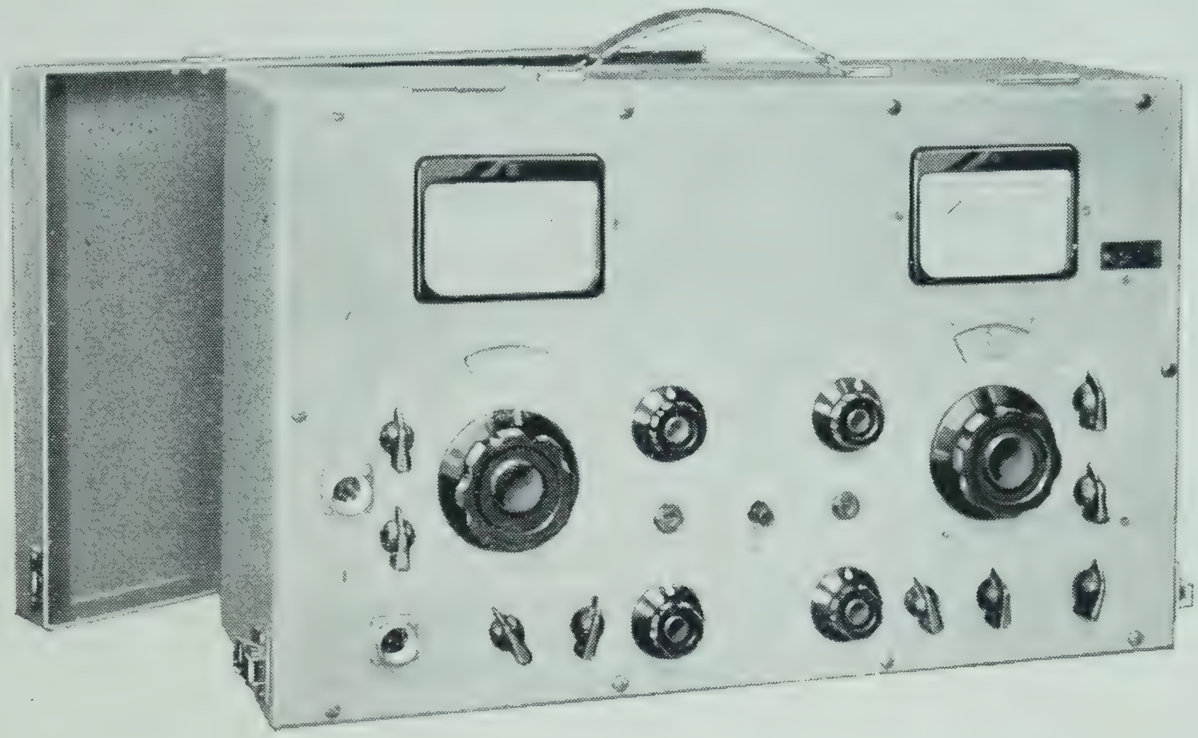


Figure 3. H.F. Field Intensity Meter Type TF.930.

frequency-modulated signals, the bandwidth of the intermediate-frequency amplifier may be changed from 'Sharp' to 'Broad.' Although all measurements are carried out while using a normal detector, an F.M. discriminator-detector is also provided for monitoring the modulation on F.M. transmissions.

The equipment is in the form of two carrying cases. One case constructed of metal, houses the instrument, all operational controls being protected by a detachable lid; the second case contains the aerial assembly.

X-Ray Dosemeter Type MME.13†. Based on a design by Dr. F. T. Farmer, late of Middlesex Hospital, the instrument integrates the x-ray dosage administered to patients during treatment. It consists of three units: ionization chamber, electrometer-amplifier, and integrating mechanism.

This thimble type Ionization Chamber is remarkably small. It is intended for insertion in the x-ray beam and may be placed either directly on the skin of the patient or mounted in the tube applicator. The materials used in the construction of the chamber create an almost 'shadowless' area over the region under treatment and give a quality dependence over the range 180 – 250 kv. A light armoured flexible cable connects the chamber with the electrometer-amplifying unit; by means of a compensating input arrangement this cable can be any reasonable length without prejudicing the operation of the instrument by excessive self-capacity. The thimble is omni-directional and, as stated, independent of wavelength over the ranges normally used.

The Electrometer-Amplifying Unit, housed in a lead-lined cabinet, is designed for wall mounting in the therapy room. A second armoured flexible cable conveys the amplified 'trigger' impulses to the Integrating Unit affixed to the control panel outside the treatment room. The 'triggering' circuit incorporates a relay which re-charges the chamber when a fixed dose (5 roentgen units) has been

applied to it. The time taken in the process is not deducted from the working cycle of the instrument and, therefore, in high dosage rates, where the charging time may be an appreciable fraction of the working period, the accuracy of measurement remains unaltered. This is an important factor in modern radiotherapy practice.

The Integrating Unit incorporates an open-dialled electromechanical counter which records the number of times the ionization chamber is discharged during treatment. The counter has a maximum scaling of 550 r. units in steps of 5. A manually operated red pointer enables the predetermined dosage to be set on the dial and a black integrating pointer adds up the applied dosage until the two pointers coincide. An alarm is immediately sounded and the beam automatically cut off by means of a shutter in the tube-head, or an interruption to the tube supplies via a relay mechanism. Transmission of an actuating impulse to the relay for the prevention of overdosage is via a cable on the integrator. A meter shows the state of discharge at which the ionization chamber stands at any instant, and also indicates that the Dosemeter is working as soon as the beam is switched on.

Stand 66

BRITISH SCIENTIFIC INSTRUMENT RESEARCH ASSOCIATION,

"Sira," Southill, Elmstead Woods, Chislehurst, Kent

Dr. A. J. Maddock and Mr. T. H. Heddle.

Magnetic Test Apparatus for Wide Temperature Range. This apparatus has been designed for measuring the ferric induction-temperature characteristics of thermomagnetic materials over a temperature range of -60 to $+120$°c. Such materials, having a Curie point within this range, are useful as compensating shunts in electromagnetic instruments.

The essential features are that the specimen is not heated by the current in the magnetizing solenoid, the volume of the specimen and its enclosing chamber are small so that change to a new temperature is rapidly accomplished, and constant temperature conditions can readily be maintained. Liquid, flowing by gravity from a tank, is used as the heating and cooling medium.

Results obtained on typical commercial alloys are exhibited. DEMONSTRATION.

Mr. H. G. Smith.

Constant-current Source Employing a Transductor. The property possessed by a transductor of producing sensibly constant output current over a range of input alternating voltage is used in this stabilizing source. It has been designed to provide the cathode-heater current for one or two thermionic valves and will deliver a current at any pre-set value between 0·2 and 0·6 amp. r.m.s. For a load resistance of 10·5 ohms at a current of 0·6 amp. (hence an output voltage of 6·3 v.), the stabilization ratio is of the order of 75 : 1 which means that the output current only changes by $\pm$ 0·16% for an input voltage change of $\pm 12\frac{1}{2}$%.

With a load change between 0 and 15 ohms (for 0·6 amp.) the current does not vary by more than 1%. DEMONSTRATION.

Mr. T. H. Redding and Mr. H. A. Sandbank.

Pneumatic Spherometer. This instrument has been designed to facilitate the rapid and accurate determination of the radius of curvature of large spherical

surfaces. Essentially it comprises a rim-type spherometer which utilizes an air-gauging system working at sub-atmospheric pressures. There is thus provided a suction which prevents relative motion of the instrument and the work under test, together with a means for accurate adjustment of the micrometer screw at the setting position.

When used as a comparator, a specified deviation from a specified radius of curvature presents itself as a variation in the reading of a water manometer; further, the uniformity of a surface can be assessed by observing the motion of the manometer consequent on sliding the instrument over the surface under test.

DEMONSTRATION.

Dr. E. Bovey and Mr. P. Unger.

Pinhole-Free Silver Mirrors. In certain optical applications it is essential that the silver mirrors employed should be pinhole-free.

The exhibit is a mirror which is quite free from pinholes even when examined using an arc light for back illumination.

The causes of pinholes in chemically deposited silver films have been investigated and by adopting special cleaning operations and modified silvering solutions, these pinholes may be entirely eliminated.

For comparison, a mirror with many pinholes is shown. This mirror was made by using the ordinary techniques of silvering. DEMONSTRATION

Stand 67

ELLIOTT BROTHERS (LONDON) Ltd.,

Century Works, Lewisham, London, S.E.13

The Elliottronic Automatic Potentiometer Recorder† (Figure 1). A self-balancing potentiometer recorder with many new features. A small D.C. signal is amplified and inverted to A.C. by a magnetic inverter, which is a form of variable impedance transformer. Thus the sensitive detector circuit includes no moving parts or contacts other than a slidewire contact. This is driven by a robust balancing motor supplied from a simple and reliable A.C. amplifier. The slidewire contact carriage is integral with the pen and pointer assembly. A pen speed of $3\frac{1}{2}$ sec. for traversing the 10 in. scale span is attained. Accuracy of measurement is to within $\frac{1}{4}$% full scale, whilst the sensitivity is of the order of 0·2% full scale. Normal range is 10 millivolts full scale. DEMONSTRATION.

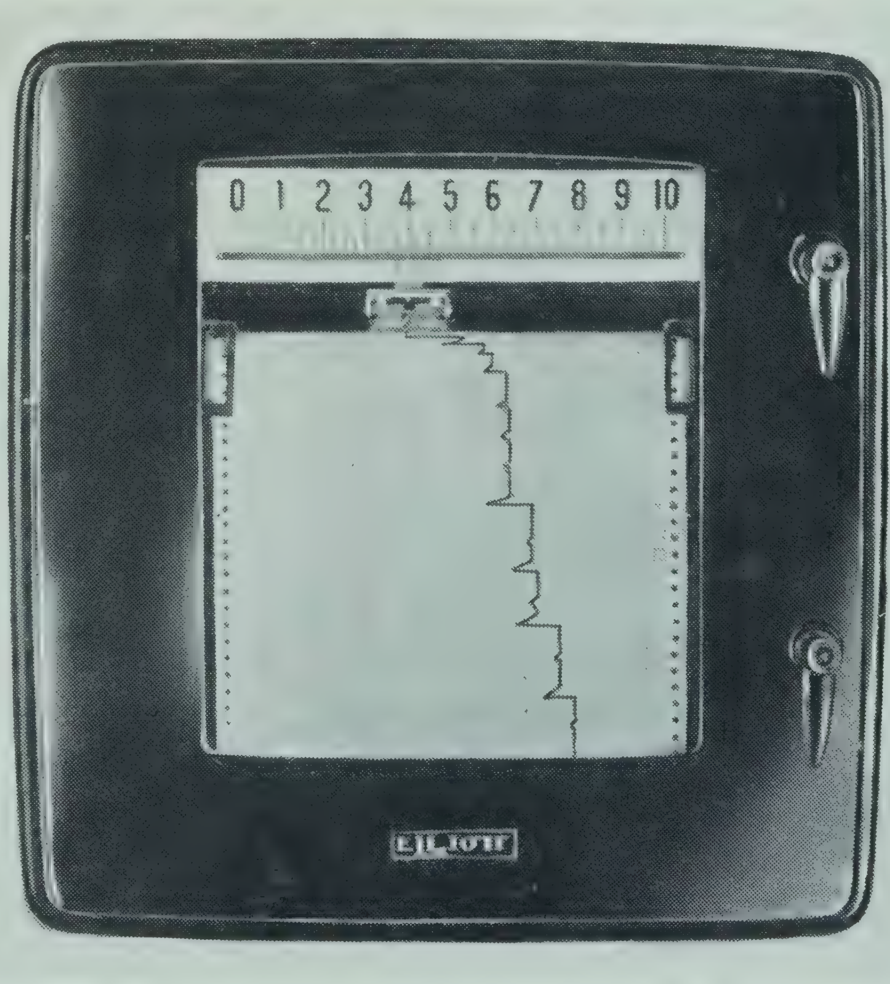


Figure 1. Elliottronic Potentiometer Recorder.

When used as a process controller, the potentiometer is fitted with an electrical proportionating circuit which provides a direct current output whose magnitude and direction correspond to the 'deviation' (error) of the controlled variable. The substitution of the two-wire electrical connection for the usual mechanical link between the recording mechanism of the controlling mechanism, is the most significant new feature of this recorder when used as a controller. It enables the control mechanism to be housed remote from the recorder if required. The recorder is shown with strip chart and circular chart presentation.

High Speed Radiation Pyrometer†. (Figure 2). The instrument has been developed to measure the temperature of steel strip and sections during rolling operations. The pyrometer head has a quartz lens which concentrates radiation from the steel on a high-speed thermocouple, the E.M.F. being amplified by a galvanometer-photocell circuit, the output of which is capable of operating a direct-writing recorder.

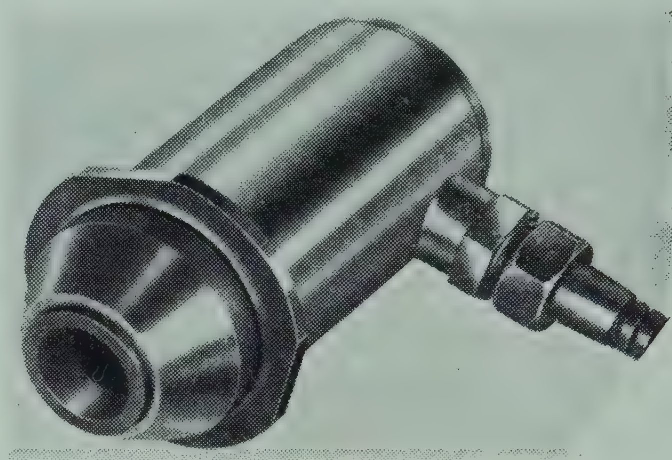


Figure 2. Elliott High Speed Radiation Pyrometer.

The instrument responds to 98% of a temperature change in $\frac{3}{4}$ second. A water-cooled sighting barrel and compressed air jet are provided for dispersal of steam and dust in the line of sight.

The design of the lens and optical system is such that the size of the hot object does not influence the accuracy of the instrument as long as the field of view is filled by the hot object.

Electrical Recorder† (Figure 3). This is a direct-writing, high sensitivity continuous chart recorder in which small overall dimensions have been combined with unusual accessibility of all working parts. It has been developed especially for applications which necessitate the use of a large number of recorders in banks and as a speed recorder for railway work in conjunction with an axle-driven generator. The instrument is effectively screened.

The movement has large working forces and is electrically damped. The recorder can be used on moving vehicles or in aircraft subject to rolling and vibration. Ink is supplied from a non-spilling trough of ample dimensions.

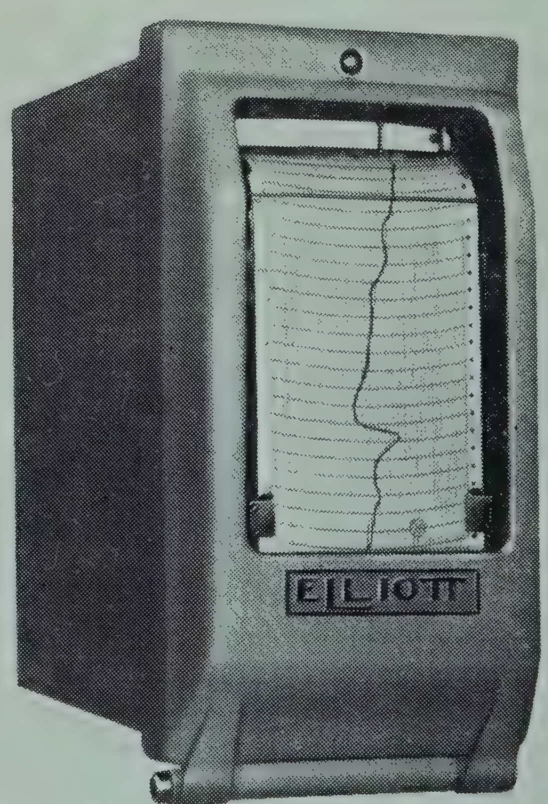


Figure 3. Elliott Electrical Recorder.

The effective chart width is 3 inches. Chart drive is by clockwork or synchronous motor with two speeds selected by a lever in the case. Standard chart speeds are 1 in. and 6 in. per hour. Full scale deflection is obtained for a power consumption of 1·0 milliwatt. Adjustable maximum and minimum contacts are fitted for the operation of alarm circuits. DEMONSTRATION.

$3\frac{1}{2}$ inch Long Scale Iron-cored Polyphase Instruments for Control Desk Use† (Figure 4). Two instruments of entirely new construction are shown:

(*a*) A three element power factor indicator of the four quadrant type, the moving system consisting of three flat moving irons arranged at 120° on a common spindle. An element of the instrument is shown in sections.

(*b*) An unbalanced load two element reactive KVA. meter, with one element in section. Both instruments are magnetically damped.

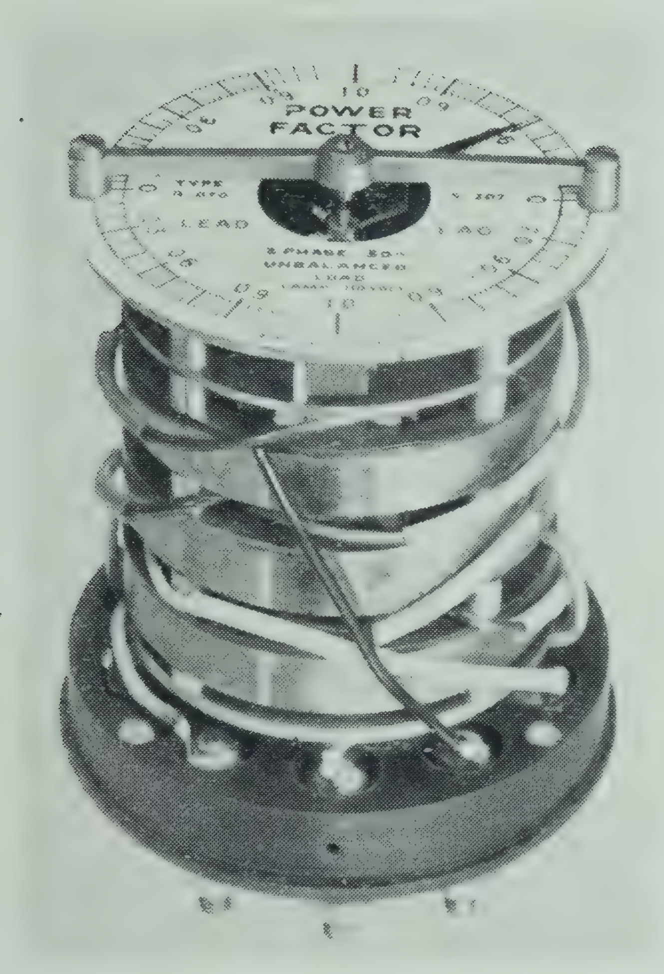


Figure 4.

Movement of Elliott $3\frac{1}{4}$ in. long scale, iron-cored Polyphase Power Factor Meter.

Figure 5.

Elliott High Sensitivity Reflecting Dynamometer, Low Power Factor Wattmeter.

High Sensitivity Reflecting Dynamometer Low Power Factor Wattmeter† (Figure 5). Designed for iron loss testing; ranges 0·5 and 1 amp., 30, 60, 120 volts giving full scale deflection with nominal VA. at a power factor of 0·1. The burden on the current coils is 0·25 VA. and the ohms/volts 75.

Heavy Duty Magnetic Amplifier: 1 H.P. Motor Speed Control†. A range of magnetic amplifiers suitable for controlling several kilowatts has been developed. A typical amplifier is demonstrated providing armature current to a 1 H.P. motor, the speed of which is accurately controlled by an electronic amplifier feeding the magnetic amplifier power stage. This arrangement is suitable for machine tool drives, controlled speed pump delivery, etc. The motor

can be given a constant speed characteristic with load, or other suitable characteristics can be introduced by networks in the amplifier. The high power magnetic amplifier is suitable for various power control applications driven either from valve amplifiers or from further magnetic amplifiers. DEMONSTRATION.

Magnetic Amplifier for Thermocouples, etc. with Cold Junction Compensation†. This amplifier has been developed as a sensitive D.C. amplifier for industrial use. It can be provided with input circuits suitable for operation from sources of resistance up to 2,000 ohms and is therefore suitable for the amplification of D.C. signals from thermocouples, resistance strain gauges, barrier layer photocells and thermistors. The output, 5 ma. in 500 ohms, is sufficient to operate direct-writing recorders and large indicating instruments.

The characteristic is made linear and stable by the use of negative feedback; the feedback voltage is injected into the input circuit so that the apparent input resistance is high compared with the source resistance. When used with a thermocouple having a resistance of 10-20 ohms, full scale deflection can be obtained for 4 mv. (about 100°C. with a copper constantan thermocouple), the current taken from the thermocouple being about 4 μa ; other ranges of lower sensitivity can be provided if required. The accuracy is to within $\pm \frac{1}{2}\%$ of full scale deflection.

In addition to its application to measurement problems the amplifier has been used without the feedback loop as a high gain amplifier for operating Post Office type relays, fitted with heavy duty contacts or mercury switches, in alarm circuits and on–off control systems. The input power to the amplifier to operate this type of relay is about 10^{-10} watts. In the model demonstrated the layout has been improved and a thermocouple cold junction compensator is fitted.

DEMONSTRATION.

Aerial Recording Magnetometer†. The instrument is a total force variometer which records, on a continuous writing recorder, variations in the earth's total magnetic force. Developed for geophysical surveying by air, it is designed with a view to easy installation in an aircraft, and comprises the following components :

detector head,	graphic recorder,
metering unit,	battery box,
orientor unit,	power unit.

The mechanical arrangement of the orienting gimbals of the detector head, has been designed to avoid gimbal lock at low magnetic latitudes.

H.S. Digital Computing Developments (Figure 6). The exhibits are examples of work in the field of automatic digital computing. It is convenient in this field to represent numbers in the binary scale and one of the exhibits illustrates conversion between decimal and binary scales. The other exhibit shows typical computing elements.

(*a*) *Decimal to Binary Converter.* This is a machine for the conversion of decimal numbers to binary numbers. The machine comprises a decimal keyboard, the electronic converting mechanism and a binary register and number display. Decimal numbers are set up on the keyboard and the binary equivalent is added to or subtracted from the binary register controlling the neon lamp display. The converter is principally for feeding binary input data to a high speed automatic computer or for preparing an input tape for such a machine. DEMONSTRATION.

(*b*) *High-Speed Binary Components.* A high-speed number generator, producing pulse trains representing two 16-digit binary numbers in serial form, with a digit time of abcut a microsecond, repeated at 2 millisecond intervals, and exhibited on a cathode-ray tube screen. The number generator is constructed partly of plug-in printed circuit plates, with silver conductors fired on glass.

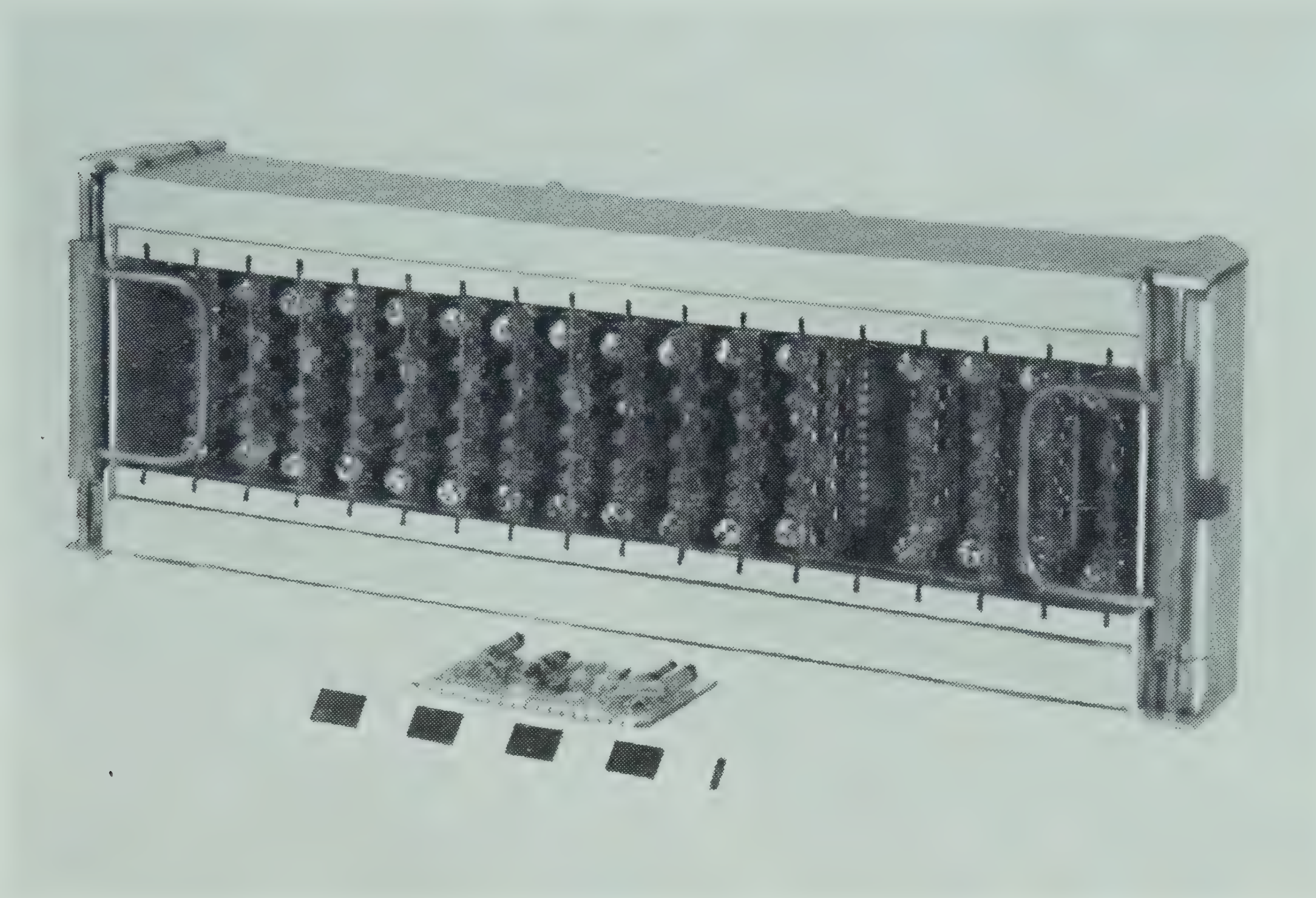


Figure 6. Components of Elliott High Speed Digital Computing System.

Other printed circuits are a double one-digit-delay circuit, and an add/subtract circuit plate. The add/subtract plate and the double delay plate may be connected as a binary adder or subtracter.

Sin/Cos Potentiometer. This instrument is designed to give sine and cosine functions of voltage over a speed range of 0 to 120 r.p.m. Nickel-chromium wire of 0·001 inch diameter is employed for the windings. The bare wire is laid up on a former $\frac{3}{8}$ inch in diameter $\times$ 2 inches long with a linear pitch of 0·0014 inch. The sinusoidal motion of the sliding contact for a constant speed input is obtained through a hypocycloid gear between the input shaft and the contact slide.

Magnetic Clutch Servo used as a 'Memory'. In telemetering, remote meter readings from high impedance sources have to be fed in succession along one metering line for operating indicators at the receiving end. The signal voltages are 'stored' and remain available for metering purposes until they are readjusted from the meter control line. The storing is carried out by potentiometers adjusted by a magnetic clutch servo. The clutches are built into a multiple unit and are controlled by a combined valve and magnetic amplifier. The servo resets the potentiometers to better than 0·25 degrees giving a reset speed of 600 degrees per second. A servo natural frequency of better than 30 c/s. can be obtained.

Incremental Follow Up for Automatic Circuit Selection. In some forms of remote control equipment an action equivalent to dialling a telephone number is required but the information is often only available as a potential from some

electronic apparatus. In the unit shown a magnetic amplifier drives a uniselector switch to select the appropriate line and replaces two electronic valves. This simple change may greatly reduce the number of valves in any large scale telemetering system, reducing the maintenance considerably. An input signal of 75 μa. operates the uniselectors and the amplifier has a power gain of 10,000.

X-Band Spectrometer (Figure 7). This instrument is designed to analyse the frequency spectrum of an X-Band pulse transmitter. A resonant cavity is loosely coupled to the waveguide from the transmitter and a lightweight piston is moved mechanically in the cavity by means of a motor driven lever action. A crystal is also coupled to the cavity and the output from the crystal is displayed, after pulse lengthening and amplification, on a cathode-ray tube. The time-base for the cathode-ray tube is obtained from a potentiometer driven by the motor and hence the display is a graph of amplitude against frequency. The frequency stand is variable and can be adjusted in the range 0 – 60 Mc/s.

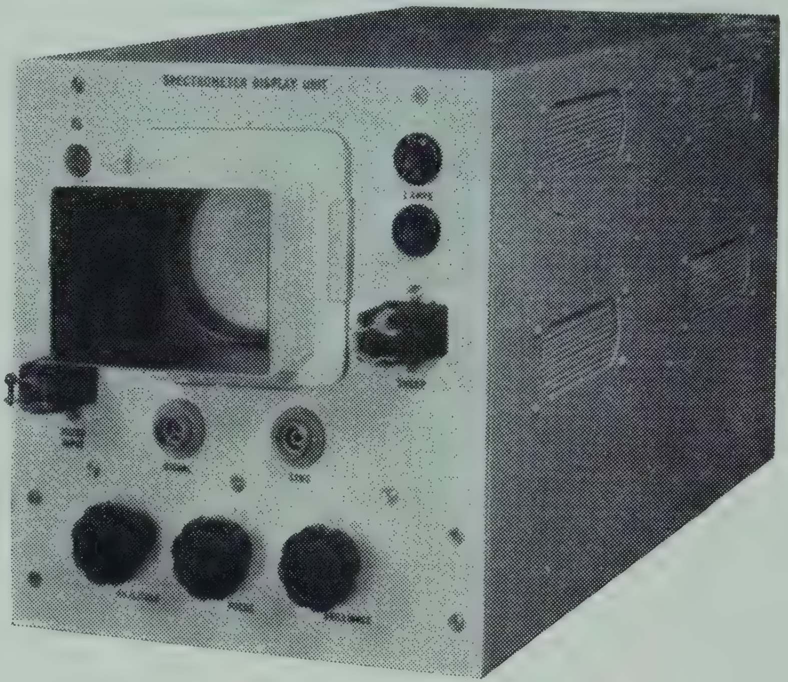


Figure 7. Elliott X-band Spectrometer.

Stand 68

MULLARD ELECTRONIC PRODUCTS Ltd., MULLARD RESEARCH LABORATORIES,

Century House, Shaftesbury Avenue, London, W.C.2

High Permittivity Ceramic K.3000†. K.3000 is a new material developed for use as high frequency by-pass condensers. The purpose of a by-pass condenser is to present a sufficiently low impedance to high frequencies and, therefore, the criterion by which a dielectric should be judged is the minimum permittivity within the working range.

'K.3000' implies a permittivity greater than 3000 over a temperature range from + 10°c. to + 70°c.

Permittivity and power factor are shown as functions of temperature. K.3000 belongs to the group of ferroelectric materials such as barium titanate or rochelle salt and is consequently very field-dependent. Hysteresis loops taken at different temperatures are shown and also the variation of the reversible permittivity for small A.C. voltages superimposed on large D.C. voltages.

The change of reversible permittivity is greater near the peak-permittivity point (30°c.) and this specific property may be made use of although it should be realized that materials with such high permittivity have an inherent tendency to a lower stability. This is indicated for example by permittivity–temperature curves for V.(D.C.) = 0 before and after the application of a D.C. voltage. At room temperature the voltage coefficient is about 0·06% per V/mm. The insula-

tion resistance measured on a sample of capacity greater than about 2500 pF. is 10^{12} ohms at room temperature and 10^{10} at 100°C. so the material can be used for coupling condensers. The breakdown voltage is 2500 volts/mm.

The material can be prepared in a variety of shapes using the standard ceramic techniques of moulding, extruding and casting.

Ferroxcube. Several grades of ferroxcube materials have been developed from mixed ferrites. Their permeability and loss–frequency characteristics depend on the ferrites used and on the method of production. Following on the introduction of manganese-zinc ferrite (Ferroxcube III†) further grades are now being demonstrated.

Ferroxcube IV. This is the name given to the nickel-zinc ferrites. Depending on the exact composition the permeability can be varied over a very wide range ($\mu = 10 \rightarrow 1000$); the losses (tan δ) also vary and are lower the smaller the permeability. If $f_{0\cdot1}$ i.e., the frequency at which the losses reach 0·1, is taken as the limiting frequency, the relation $\mu f_{0\cdot1} = 1{\cdot}5 \times 10^9$ gives an idea of the limiting frequency.

Compared with Ferroxcube III the nickel-zinc ferrites have the advantages that (i) the A.C. resistivity is greater by a factor of $10^5 - 10^6$, and (ii) the permittivity at high frequencies is much smaller. Ferroxcube IV can thus be used up to very high frequencies (100 Mc/s.) due to the lower eddy current losses; the smaller product μK meaning also that limitations due to dimensional effects will not occur except at very high frequencies.

Ferroxcube V. This material has been developed to improve the rather low saturation magnetization (3000 gauss) of Ferroxcube III. In this material the saturation magnetization is between 4500 and 5000 gauss, with initial permeability $\mu_0 = 500$. DEMONSTRATION.

The Measurement of Noise Factor of Travelling-Wave Tubes at 10 kMc/s. The determination of the noise factor of the travelling wave tube at 10 kMc/s. involves three measurements : (*i*) the noise factor of a 10 kMc/s. receiver, (*ii*) the available power gain of the travelling-wave tube, and (*iii*) the noise factor of the receiver preceded by the travelling-wave tube.

The measurements of noise factor require the use of a signal generator giving a known and variable output power, and a receiver having an output meter of known law.

The signal generator uses a klystron as the source of radio-frequency power and the output to the waveguide system is taken from a piston attenuator. The signal generator is doubly screened to reduce to negligible levels any stray radiation from the klystron. The output power is determined at high level by means of a thermistor, and the piston attenuator is used to reduce this known output to noise levels. Square wave modulation is also provided for assisting in the alignment of the travelling-wave tube.

The receiver consists of a balanced mixer and 45 Mc/s. pre-amplifier followed by a main I.F. amplifier which has a bandwidth of about 2 Mc/s. The mixer is based on the magic-T junction and is mounted so that it forms a single unit with the pre-amplifier. The final detector is either a thermocouple which is used for

measurements, or a diode which is used for alignment because of its shorter delay time. The noise factor of the receiver is about 10 times.

The measurement of gain is made by the use of a pair of Y-switches which enable the travelling-wave tube to be put in or out of circuit. Standard techniques and equipment are used for impedance matching and for the measurement of standing-wave patterns. DEMONSTRATION.

Moving Image Converter. The Moving Image Converter is used in this instance as a quick-acting optical shutter.

The image of a Mullard flash tube is focused on to the photo-cathode of the Image Converter, and the electron image from the cathode is focused magnetically on to a fluorescent screen, where the image of the flash tube may be seen.

The electron image may be interrupted by means of a negative bias potential applied to one of the electrodes of the Converter, when superimposing a short positive pulse on the electrode restores the image, but only for the duration of the pulse, which may be as short as 1 μ sec.

Using a manually variable delay circuit coupled to the triggering electrode of the flash tube, the image tube pulse may be made to occur at any desired time after the triggering of the flash tube so that the growth and decay of the discharge may be observed. DEMONSTRATION.

Valve Impedance Test Gear.

The Measurement of Input Damping on Valves at High Frequencies. The valve impedance test gear has been developed for the accurate measurement of input and output capacitance and damping resistance of thermionic valves under any given operating conditions. The gear operates on a similar principle to the conventional Q meter ; it consists of an oscillator feeding a tuned circuit which includes the valve under test across which is connected a bridge-type, high-frequency valve voltmeter. It differs from a Q meter, however, in that the power developed in the tuned circuit is varied by means of a piston attenuator so that the voltage is adjusted to a predetermined value. This system possesses two major advantages : (*a*) in the measurement of the variation of input damping with bias the voltage excursion on either side of the working point is the same over the characteristic ; (*b*) the accuracy of measurement is mainly determined by the piston attenuator which may be made to a high degree of precision.

The frequency range is 10-150 Mc/s., and the voltage applied to the valve under test is 50 mv. r.m.s. DEMONSTRATION.

Ultrasonic Soldering Iron†. Aluminium and its alloys can be tinned if they are subjected to intense ultrasonics at the same time as molten solder is applied, since the violent agitation occurring disrupts the tough oxide skin which is nearly always present. In the instrument shown, a stack of magnetostrictive laminations is coupled to a half-wavelength bar of the same resonant frequency, both parts being mounted nodally. A considerable amplitude of vibration can thus be produced at the free end of the bar. This is heated electrically and can then be used, either in the same way as a conventional soldering iron, or as the foundation for a bath of molten solder, in which small parts are tinned by dipping.

The vibrator is kept in oscillation at its resonant frequency by means of a small vibration pick-up coil mounted behind it, the output from which, after amplifi-

cation, is fed back to the driver coil. By this means it is possible, with quite a simple electronic unit, to provide 50 watts of high-frequency power for the transducer. DEMONSTRATION.

Broad Band Oscilloscope†. Modern electronic techniques are increasingly concerned with high speed transients, and the observation and measurement of their waveforms has hitherto been a matter of some difficulty. The new Mullard Oscilloscope is an instrument intended to simplify this problem. Many features are combined in it that have previously only been found in very specialized apparatus.

It includes identical X and Y amplifiers, having a bandwidth from D.C. to 20 Mc/s. (3 db. down). The sensitivity is 100 mv/cm. at input conditions of 10 Megohms and 5 PF., or 10 mv/cm. at 1 Megohm and 15 PF.; for the low capacity input, a probe is used.

A new time-base system has been employed, combining the desirable features of the conventional, free-running type with the advantages of the triggered slave time-base. Three parameters are under the control of the operator, repetition frequency, sweep velocity, and the delay time between a triggering pulse and the start of the sweep. The user can thus observe any portion of any waveform. The minimum delay has been reduced to 0·05 μsec. Linear sweeps are provided, of durations between 0·2 μ sec. and 1 sec., and in each case appropriate ranges of delay times and repetition frequencies are available.

The cathode-ray tube used has a 13 cm. diameter screen giving a blue-white trace. Additional facilities provided in the instrument include an amplifier for time-marking by brightness modulation, and accurate X- and Y- shift controls, calibrated respectively in times and in voltages. DEMONSTRATION.

F-M Signal Generator — Type E.7572†. This equipment is primarily intended for the servicing of F-M receivers operating in the 90 Mc/s. region. The variable frequency F-M output is obtained by mixing the output of a fixed frequency F-M oscillator with a variable frequency C.W. oscillator. R.F. or I.F. test signals are obtained by the use of a high-pass or low-pass filter in the output. A frequency range of 2 to 20 Mc/s. and 80 to 104 Mc/s. is covered and the output voltage is continuously variable from 1 μv. to 0·1 volt by means of a coarse and fine attenuator. Two forms of modulation are provided: sine wave with a frequency of 500 c/s. and a deviation variable between 0 and 100 kc/s., and saw-tooth at a repetition frequency of 100 c/s. with an excursion of 500 kc/s. peak to peak. The instrument is mains operated and is housed in a metal case 8½ in. × 8½ in. × 15 in. overall dimensions. The weight is 23 lb.

Large Adjustable Permanent Magnet†. Modern adjustable permanent magnets compare very favourably indeed with electromagnets of similar performance from the point of view of size and installation space if one considers the supply and stabilization of power source.

Mullard 'Ticonal' permanent magnets are being increasingly used in industry and for research purposes due to their extremely high stability. Special installations can be supplied, such as the model shown, which represents Magnet Assembly Type MD.1157, designed for atomic research where a field is required which may be regulated from zero to 10,000 gauss. This is only one of the large adjustable permanent magnets designed and manufactured by Mullard.

There appears to be no limit to the size of adjustable permanent magnets that can be made to these principles and special magnet assemblies can be produced to suit individual requirements where extreme stability is of paramount importance.

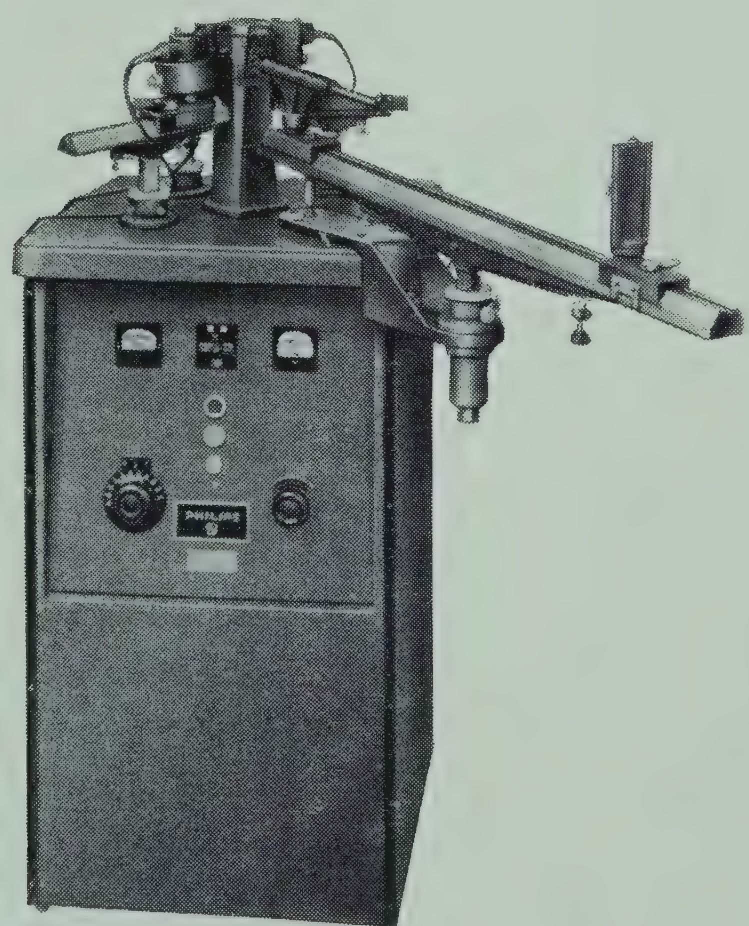
High stability adjustable 'Ticonal' magnets can be hand-controlled or power-driven with remote control. This latter feature may be a necessity where these magnets are used for atomic research purposes.

Stand 69

PHILIPS ELECTRICAL Ltd.,

Century House, Shaftesbury Avenue, London, W.C.2

Philips X-Ray Diffraction Unit (see Figure). This consists of a rectified high tension transformer unit having an output of 60 kv. 20 ma. to which a sealed-off x-ray tube is directly attached at the H.T. terminal. The anode of the tube is grounded and arranged for water cooling from the mains. The tube is of the four-window type and the vacuum unit can be easily exchanged for another having a different target material.



X-Ray Diffraction Unit.

Machined faces in the vicinity of the tube apertures permit the attachment of camera tracks ; the circular table for other types of camera is also provided. An extremely compact control unit is mounted on the H.T. transformer, and a pressure operated switch safeguards the tube against the failure of the water supply.

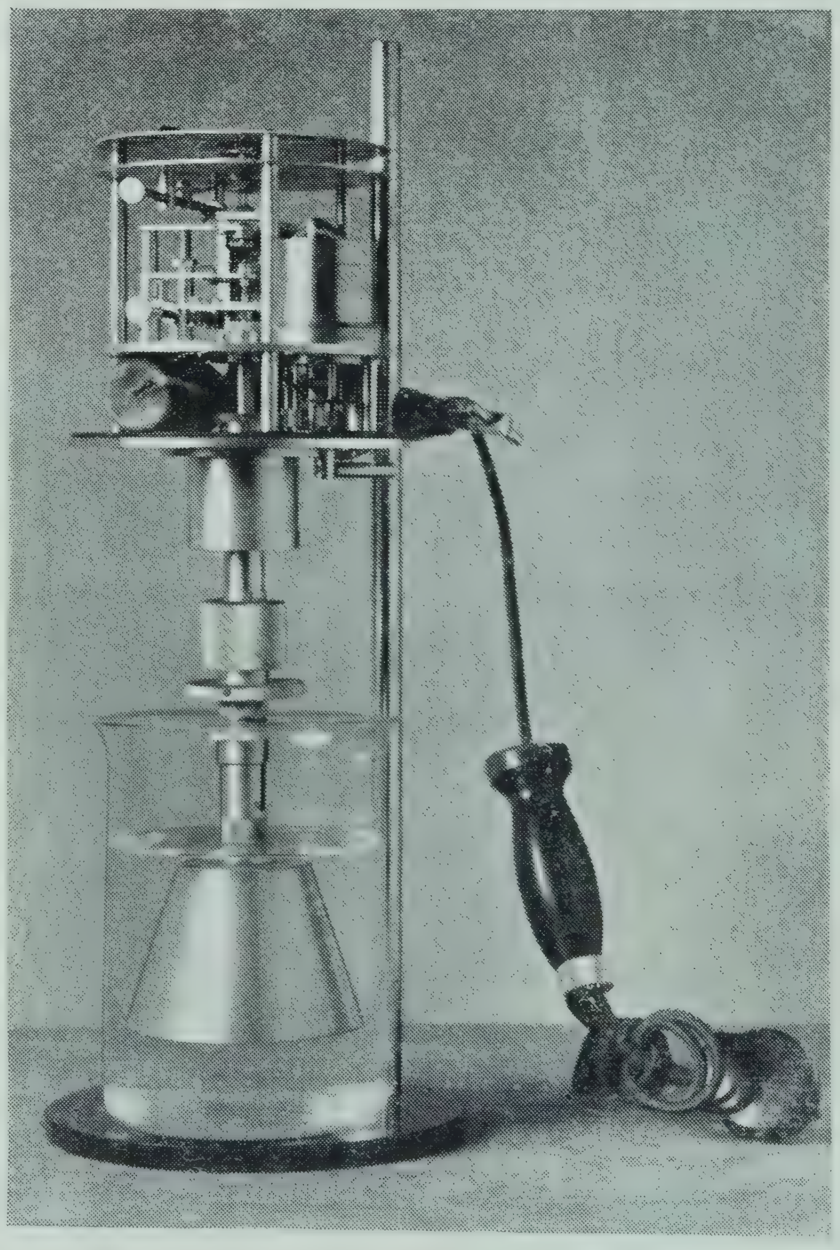
Stand 70

FERRANTI Ltd., Hollinwood, Lancashire

Precision Potentiometers. These are toroidally wound Potentiometers having an accuracy of 15 minutes. They are available with elements of 1 in. or 2 in. diameter either single, double, or five gang units. Windings are available in precious metals giving good contact resistance and low torque operation. They are of use in all forms of computing apparatus or for use as pick-offs from instruments which have low operating torques.

High Speed Recording Cathode-Ray Tube. This tube has been developed for the photographic recording of high speed transients when surge testing Ferranti transformers. It is the result of an endeavour to overcome the problems which have arisen in using a continuously evacuated surge oscilloscope. The 6 in. diameter tube has electrostatic deflection and magnetic focusing. With the final anode voltage at 15 kv. the writing speed is of the order of 3,000 km. per second, without reduction in image. Photographs illustrate some of the excellent results obtained with this tube.

Portable Viscometer† (see Figure). The instrument gives immediate readings of viscosity on a scale calibrated directly in poises or centipoises. It is of the Couette coaxial cylinder type with an inner cylinder suspended in jewelled bearings and free to rotate against a calibrated spring, and an outer cylinder driven at constant speed by a two-phase synchronous motor of high torque. The continuous drag exerted on the inner cylinder causes a deflection proportional to the viscosity. For the determination of the anomalous behaviour of non-Newtonian liquids a wide range of shear rates is provided by the combined effect of a quick-change three-speed gear box and a set of interchangeable inner cylinders. Thus the range of a single instrument can extend from a few centipoises to several hundred poises. The viscometer is compact and easy to handle. The weight is $3\frac{1}{2}$ lb.



DEMONSTRATION.

Hot Cathode Mercury Argon Discharge Lamps. The well known Ferranti crater lamps and spectral source lamps are displayed employing Neon, Mercury,

is to within $\pm$ 1% of the scale range of 400 mm. Hg, chosen to be anywhere in the range 0 — 2 atmospheres. A two pointer presentation is employed, the sensitive pointer making one revolution per 100 mm. Hg change.

Thus the instrument may find application in chemical engineering plant as a vacuum gauge and in engine test-bed work as a boost gauge. DEMONSTRATION.

Single Channel Dynamic Strain Recorder†. In industry and research it is frequently desired to record some rapid transient or oscillatory phenomenon, either electrical or mechanical in origin. The former can already be dealt with in a large number of cases by means of the Kelvin and Hughes range of High Speed Pen Recorders. Mechanical variables, such as strain, force, displacement, acceleration, fluid pressure, fluid flow, temperature, etc., require to be translated into electrical quantities for recording, and for this purpose conversion elements of the generating or of the variable-impedance type may be used.

Variable-impedance conversion elements are found to be extremely convenient in use ; one advantage is that they can be used as modulators in conjunction with A.C. bridge circuits and carrier-type amplifiers in order to provide response at frequencies from zero upwards without introducing the disadvantages of direct-coupled high-gain amplifiers. This method of use can be made to give high sensitivity and stability, excellent amplitude and phase characteristics, versatility of application, and easy calibration by static methods.

An equipment using the principles outlined above has been designed for use with the Kelvin and Hughes Single-Channel Recorder Mark V. Contained in one unit are the bridge circuit, 2 kc/s. oscillator, carrier amplifier, demodulator, D.C. amplifier and power supplies. The Recorder forms a second unit.

The bridge circuit contains two fixed ratio arms, fine and coarse balance controls, quadrature balancing and function selector switch. A calibrator enables a range of resistive unbalance values to be switched in parallel with part of either ratio arm, and a stud attenuator is provided. A valve voltmeter is also fitted as a balance indicator.

Pick-up elements of the following types may be used :

Resistance units, 50 to 200,000 ohms, used in pairs.

Inductance units of the balanced type, 2 to 400 mH. per half.

Capacity units from 100 to 700 pF., including cable capacity. These should be of the single type, and a range of balancing capacitors is fitted in the equipment.

Units containing all four arms of a bridge, 50 to 200,000 ohms per arm.

Using maximum amplification the sensitivity is such as to give full-scale deflection for less than :

(*a*) 0·005% change of resistance in a 2,000 ohm resistance pick-up.
(*b*) 0·01 ohm change in a 100 ohm resistance pick-up.
(*c*) 0·005 mH. differential per arm in a 100 mH. inductance unit.
(*d*) 1 pF. change in a capacity unit.

Access to the D.C. amplifier input is provided ; at this point the sensitivity is about 1 volt for full-scale deflection and the input impedance 1 megohm.

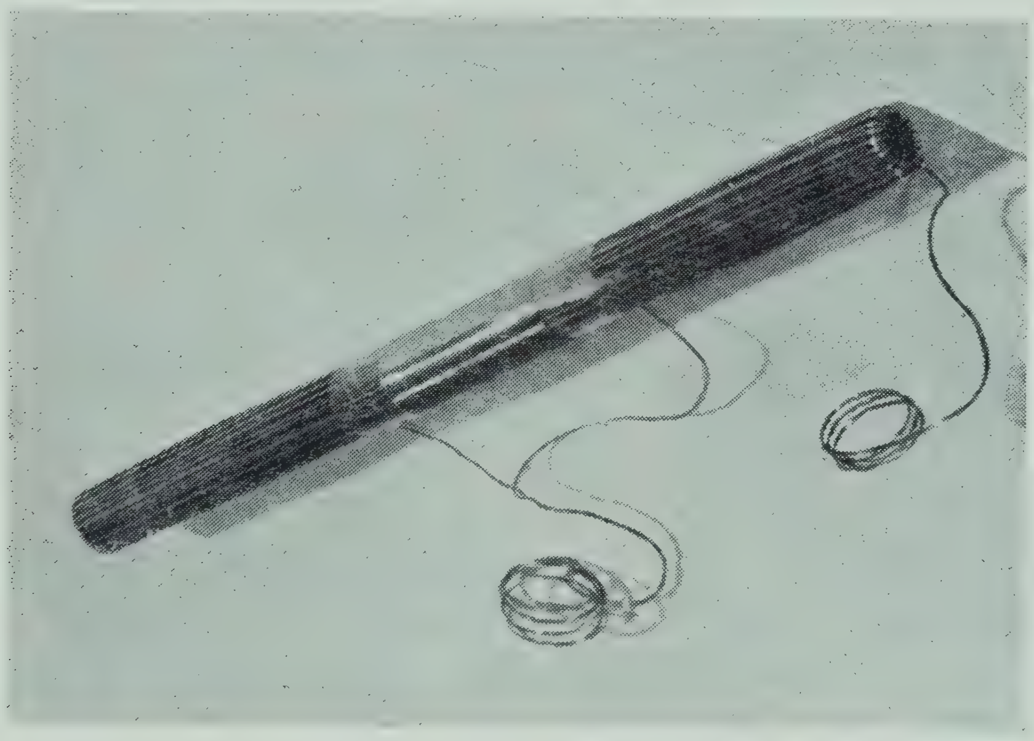
The recorder is a standard Kelvin and Hughes Single-Pen Recorder Mk. V, using 55 mm. Teledeltos paper to provide a dry, permanent fine black trace on a light grey background.

The paper is driven by a synchronous motor, through a two-speed gear-box.

An auxiliary gearbox is also fitted enabling three pairs of speeds between 0·25 and 10 cm/sec. to be obtained by inserting the gearwheels in different positions.

Maximum deflection of the pen is 2 cm. on each side of a centre zero, and the sensitivity of the 5,000 ohm moving coil is 0·2 mm. per volt. Response is uniform within 6% from 0 to 60 c/s. DEMONSTRATION.

'Transflux' Magnetic Detector Elements† (see Figure). The purpose of these elements is to give an output voltage which is directly proportional to the magnetic field strength along its axis. The principle employed is different from that in other flux valves inasmuch as the magnetic material of the element is magnetized to saturation by alternating current in a direction at right angles to the direction of the magnetic field to be measured. The material as seen by this field varies in permeability during each half-cycle of the magnetizing current so that if there is a unidirectional magnetic field along the axis, there will be changes in induced flux along that axis which will give rise to a voltage of double the magnetizing frequency to be developed in a coil wound around the element.



The form of the element as seen in the photograph is a cylinder of magnetic material wound toroidally for the magnetizing current and along the length for the induced voltage. Thus the two magnetic circuits are at right angles, ensuring little or no interference between each other. The toroidal winding ensures uniform and efficient magnetization of the material and hence the whole length of the element is 'effective' for inducing magnetism unlike, say, the element in the G.111 Compass detector, in which the ends of the wires cannot be magnetized to the same extent as the centre of the wires. This brings us to a further great advantage, i.e., no matching of ferromagnetic wires of strips or magnetizing coils is required and there is no danger of any matched conditions changing with time and use.

To make full use of this type of element a material known as 'Ferroxcube' is used. This material although brittle makes a robust unit and its magnetic properties are unaffected by physical treatment as with highly permeable materials. The very low losses of this material also enable higher frequencies to be used with considerable increase in sensitivity giving the possibility of outputs greater by a factor of 100 or even more than that of a G.111 compass detector element of about the same physical size and used under the same conditions. DEMONSTRATION.

Stand 73

SIEMENS RESEARCH LABORATORIES,

Woolwich, London, S.E.18, and Preston, Lancs.

33,000 volt 3-core Submarine Power Cable†. This cable has 0·25 in. conductors and is capable of transmitting 18,000 kVA. It was laid, in one continuous length of nearly 3 miles and weighing 220 tons, across the Solent in August, 1949, to augment the electricity supply to the Isle of Wight from the mainland. Final tests were made and the cable put into commission in September, 1949.

The shore end, which is exhibited, is 6 in. in diameter.

Apparatus for Automatic Voltage Grading of Gas-filled Surge Protectors. The gas-filled surge protector is a gas-filled device consisting of two heavy electrodes mounted close together and designed to be capable of building up a low resistance arc within a very short interval of time.

A preliminary surge of 500 volts A.C. is applied to the protector for 0·25 second. The grading is then obtained by means of an auto-potentiometer mechanism which is arrested when the protector breaks down. A visual indicator shows the breakdown voltage ranges. DEMONSTRATION.

Variable Intensity Screen for Viewing X-Ray Films†. The detail in an x-ray film can be seen more clearly if the illumination is matched to the particular film density.

The unit exhibited has an illuminated screen approximately 24 in. by 18 in. and the illumination which is provided by blue fluorescent and/or incandescent lamps is variable in intensity and colour to suit the film under examination. DEMONSTRATION.

A Source of Near Ultra-Violet Radiation of Known Energy Distribution. The tungsten filament is mounted in a quartz envelope. Due to the high transmission of quartz in the region 3000 to 4000 A. the temperature of the filament may be used to determine the ultra-violet emission in this region. By varying the source temperature the distribution of energy can be varied. The use of quartz in place of glass for the containing bulb makes possible a highly compact source. DEMONSTRATION.

A Method for the Initiation of the Arc in High Pressures of Gas or Vapour†. A short tungsten filament capable of being brought to incandescence may be used to provide instant ignition of a heavy current arc between two tungsten electrodes in a high pressure of mercury vapour. The method is shown to be applicable to pressures of inert gas (argon, krypton, xenon) of the order of 1 to 5 atmospheres. DEMONSTRATION.

Stand 74

H. TINSLEY & CO., Ltd.,

Werndee Hall, South Norwood, London, S.E.25

Simmons Portable Shielded Anemometer† (N.P.L. design). A new portable hot wire anemometer for the measurement of low air speeds. The hot wire is enclosed in a twin bore silica tube, and its temperature is measured by a butt thermocouple of nichrome constantan in the other bore. The resulting head

is of very small size (the element being 1 in. long) and has remarkable permanency of calibration. Measurements are taken by galvanometer deflections, and the air speed read from calibration curves supplied. The complete instrument is portable and self-contained, the head being the only external item. Ranges are 0·4, 2·0 and 5·0 ft. per sec. Accuracy to within $\pm$ 2%.

Portable Direct Reading Strain Gauge Bridge†. A compact portable strain gauge bridge, having a single six inch dial calibrated directly in strain. A small dial calibrated in gauge factors over the range 1·8 to 2·4 is provided for setting to the gauge factor of the gauge in use. The bridge has a self-contained reflecting galvanometer, internal batteries and apex resistors suitable for a single gauge circuit. It can also be used with multiple gauge circuits by the addition of an external apex unit. The bridge has four ranges $\pm$ 0·5%, $\pm$ 0·25%, $\pm$ 0·1%, $\pm$ 0·05% strain.

Portable D.C. Potentiometer†. This is an entirely new model of the well-known Tinsley Portable General Utility Potentiometer, which has been completely re-designed. The new potentiometer is very much smaller in size and lighter and uses the new mercury 'Kalium' cells in place of accumulators. Accuracy overall is 2 in 10,000.

A.C. Stabilizer† (Dr. Patchett's design). A new model with considerably improved temperature compensation, the output remaining within 0·1%, despite any changes in ambient temperature between 15° and 30°C. The instrument has protective devices for over and under voltage. The rating is 500 VA. for input voltage changes of $\pm$ 4%. It is insensitive to frequency changes over the range 48 to 52 c/s. The total harmonic distortion due to the stabilizer is less than 1%. The short term stability is within 2 parts in 10,000, and the stabilizer is suitable for use in the most precise A.C. measurements.

Very Sensitive Contact Modulated D.C. Amplifier† (Admiralty Signals Establishment design). An A.C. mains-operated D.C. amplifier for the amplification of very minute D.C. signals of a fraction of a microvolt. The amplifier gives 1 volt output into 500 ohms for an input voltage of 0·04 microvolt. The output load usually is a pen recorder, and in this condition the equivalent noise input is about 3×10^{-9} volts. The D.C. input is chopped at 75 c/s., by specially designed contactors. It is then amplified as A.C., and finally rectified by contactors, operated in synchronism with the input contactors.

Sealed Strain Free High Resistance Standard. The resistance element consists of bare manganin, wound in a tight spiral 3/32 in. diameter. The resulting spiral is then wound in an insulated groove on a copper block former, which is then mounted in a close fitting copper case with hermetically sealed terminals. The resistance element is fully annealed after spiralling, and receives a further low temperature anneal after mounting on the former. The resulting resistance is strain free and extremely stable, an accuracy of 1 in 100,000 being attained, with a reliability comparable with that of the 1 ohm standard. They can be constructed for either 100 or 1,000 ohms.

High Precision Diesselhorst Potentiometer†. This most modern version of the Diesselhorst potentiometer incorporates an independent standardizing

circuit of an improved pattern. The potentiometer requires a 2 v. accumulator only. It has a sub-division of 1 in 100,000 with an accuracy of potential sub-division of the same order. The two ranges are 0·1 volt sub-divided to 1 microvolt, and 0·01 volt sub-divided to 0·1 microvolt.

Compact Direct Reading Portable Strain Meter†. A small portable self-contained spotlight reflecting galvanometer with internal bridge ratios and calibrating circuit for use with resistance wire strain gauges. Strain is read directly from the galvanometer deflections, the 10 cm. scale being calibrated in strain. The calibrating circuit permits the use of gauges with any gauge factor between 1·8 and 2·4. The instrument has two ranges $\pm$ 0·5% and $\pm$ 0·1% strain, and with the aid of an external selector switch and apex unit can be used with a large number of gauge circuits. It has a self-contained apex resistor for single circuit measurements. Maximum error is within $1\frac{1}{2}$% of full scale reading in addition to any error in gauge factor of the strain gauge.

Wide range Bridge Amplifier with tunable Filter Network. A resistance-capacity coupled bridge amplifier having resistance-capacity filter networks in two of its stages, which can be tuned over a wide range of frequencies by means of calibrated dials on the front panel. The frequency range is from 16 c/s. to 160 kc/s. in 4 ranges.

Electrometer Amplifier. This instrument is designed primarily for use in the measurement of high insulation resistances of the order of 10^{-17} ohms. but can also be used for the measurement of very minute currents of the order of 10^{-15} amp. or in conjunction with a D.C. potentiometer for measuring potentials in very high resistance circuits. The device utilizes a twin electrometer tetrode in a balanced bridge circuit, a sensitive galvanometer being used as the indicator. High resistances are fitted internally for use as standards in insulation and current measurements.

Electrical Resistance Wire Strain Gauges for Large Strains†. A new strain gauge which will give consistent results and a linear response for strains up to 4%.

A New Sensitive Portable Galvanometer†. A completely new and improved model of the well-known Tinsley portable galvanometer, having better electrical characteristics and with a new form of case.

Desk Type Galvanometers of Small Size. These two new types of galvanometer use a new short suspension, and as a result there is a considerable saving in the height of the galvanometer. The first model is for bench use, and has a long (20 cm.) scale. The second model is for field use, and has a folding scale to reduce the size still further. Both galvanometers are of the spotlight reflecting pattern. The dimensions of the second are 20 cm. $\times$ 14 cm. $\times$6 cm.

Galvanometer incorporating an Optical Magnifier†. This is a version of the new sensitive portable galvanometer, but by the addition of a simple optical magnifier, due to Dr. Bloch, an equivalent scale distance of $1\frac{1}{2}$ metres can be obtained in a small portable case. These galvanometers have a sensitivity of 2,200 mm. per microampere for a resistance of 450 ohms, with an overall box size of 22 cm. $\times$ 14 cm. $\times$ 14 cm.

Stand 75

THE ZENITH ELECTRIC CO., Ltd.,

Zenith Works, Villiers Road, Willesden Green, London, N.W.2

Zenith Automatic Voltage Regulator† is designed for Research and Industrial purposes where a constant voltage supply within close limits and at the same time independent of frequency changes is essential. The Automatic Regulator incorporates an Electronic Relay of new design and improved performance operating in association with a motor driven variable transformer of toroidal construction controlling the input to an auxiliary booster unit in such a way that comparatively large loadings up to 20 kVA. single-phase may be safely handled. Constancy of output voltage is automatically maintained within limits of 1% with variations in the incoming supply up to $\pm$ 10%. The model exhibited is arranged so that all parts and components can be clearly seen and examined under operating conditions. DEMONSTRATION.

Latest designs of **Variable Transformers**†, giving very fine voltage regulation under load conditions, include electrically operated models for remote control, and a duplex model for controlling two output circuits independent of each other from a single main supply source.

To meet the requirements in modern aircraft equipped with generators giving supplies at 1,600 and 2,000 c/s., a small variable voltage transformer is shown which has been designed to give a range of voltage regulation of from zero to the maximum dealing with loads up to 500 VA. These transformers are equipped with magnetic cores of the extremely low loss type.

Dielectric Test Equipment† of improved design is shown with wide output voltage range and automatic features ensuring full protection.

Stand 76

SANGAMO WESTON LIMITED,

Enfield, Middlesex

Model S.123, Photronic Cell, 45 mm. diameter†. Cells are available with outputs ranging from 80 to 140 microamperes at 40 foot candles and 1,600 ohms external resistance. These are the barrier layer selenium rectifier type of photoelectric cells and for most purposes require no external current supply to operate D.C. instruments or relays. Cells are fitted behind glass windows in plug mounting moulded bakelite cases and are supplied with plug bases.

Model S.75, Multi-Range Test Set†. This has 53 ranges for measuring A.C. and D.C. current and voltage, resistance and insulation. It is completely self-contained and requires no external accessories or power supply. It has a sensitivity of 20,000 ohms per volt on all D.C. voltage ranges and 1,000 ohms per volt on A.C.

It complies with the requirements of B.S.S. No. 89 in respect of First Grade instruments. It has the following ranges :

D.C. Millivolts :	75, 150, 300, 750.
D.C. Volts :	1·5, 3, 7·5, 15, 30, 75, 150, 300, 750, 1,500.
D.C. Microamperes :	75, 150, 300, 750.
D.C. Milliamperes :	1·5, 3, 7·5, 15, 30, 75, 150, 300, 750.
D.C. Amperes :	1·5 3, 7·5, 15.
A.C. Volts :	7·5, 15, 30, 75, 150, 300, 750, 1,500.
A.C. Milliamperes :	75, 150, 300, 750.
A.C. Amperes :	1·5, 3, 7·5, 15.
Ohms :	0-500, 0-50,000, 0-500,000.
Megohms :	0-5, 0-50*, 0-500*.

Model S.63, Circular Scale Ratiometer†. Among the aircraft instruments on show is an example of Model S.63, Circular Scale Ratiometer for use in conjunction with a thermometer bulb, an electrical oil pressure transmitter or an electrical position transmitter. Dependent upon its auxiliary equipment, it can be used to indicate temperatures, pressures or positions.

Model S.78, Circular Scale D.C. Moving-Coil Instrument†. Developed primarily for aircraft, this instrument can be supplied as an ammeter or voltmeter. When used as an ammeter, it requires an external shunt of 50 mV. drop.

Model S.122, Pressure Transmitter†. This is mainly for the indication of oil pressures on aircraft in conjunction with a suitable ratiometer type indicator.

Model S.132, Position Transmitter†. This device operates in conjunction with a ratiometer indicator to indicate rotational movement of a shaft, or by the addition of a link, the movement of a rod or lever. It consists of a toroidal resistance winding housed in a moulded Bakelite case. A wiper arm carries a spring loaded contact tip, which wipes one side of the winding. The transmitter operates on 24 volts D.C., but can be supplied to operate from other voltages or from an A.C. source. Angle of movement 20–270°.

Model S.130, Warning Indicator. A visual indicator of the 'doll's-eye' pattern, actuated by permanent magnet moving-coil mechanism and operable on small inputs.

Model S.134, Weston Standard Cell†. Two types will be on show ; the normal or saturated cell, 1·01824 volts at 20°C. and the standard or unsaturated cell E.M.F. 1·0186 volts at 20°C. Characteristics of this type are better suited to industrial requirements. The accuracy is to within 0·01%.

*Over the upper part of these two ranges the internal supply is approximately 500 volts, D.C, and insulation measurements from 1-500 Megohms can be made.

Stand 77

DAWE INSTRUMENTS Ltd.,
130, Uxbridge Road, Hanwell, London, W.7

Moisture Meter for Textiles, Type 2104† (Figure 1). An equipment for measuring and controlling the moisture content of textile materials in terms of the natural regain during the drying processes. The operating principle is based upon the fact that a static electric charge develops on warps and cloths of fibrous material during drying and movement. The magnitude of this charge is related to the moisture content and is independent of the grade or thickness of the cloth. The electric charge is collected from the full width of the yarn by means of an electrode mounted at the delivery end of the drying machine, thence conveyed to the measuring instrument and converted into an indication of the moisture content, shown both by meter and signal lights. Semi or fully automatic control can be operated from this instrument.

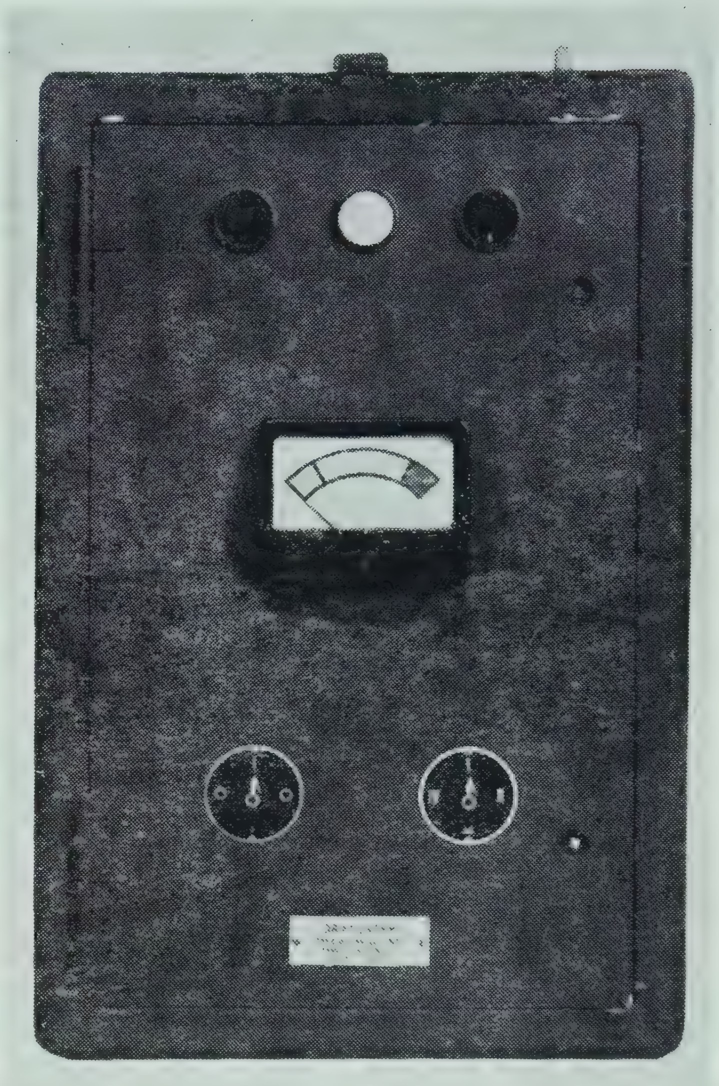


Figure 1.
Moisture Meter for Textiles, Type 2104.

Dynamic Balancing Machine Type 1250B† (Figure 2). An instrument for directly determining the amount and angular position of unbalance occurring in rotating bodies in order that dynamic balance may be achieved by the addition or removal of weight. By this means vibration is eliminated and wear and stresses upon the bearings greatly reduced.

The body to be balanced is placed in the half bearings of the two cradles and belt driven from the overhead shaft.

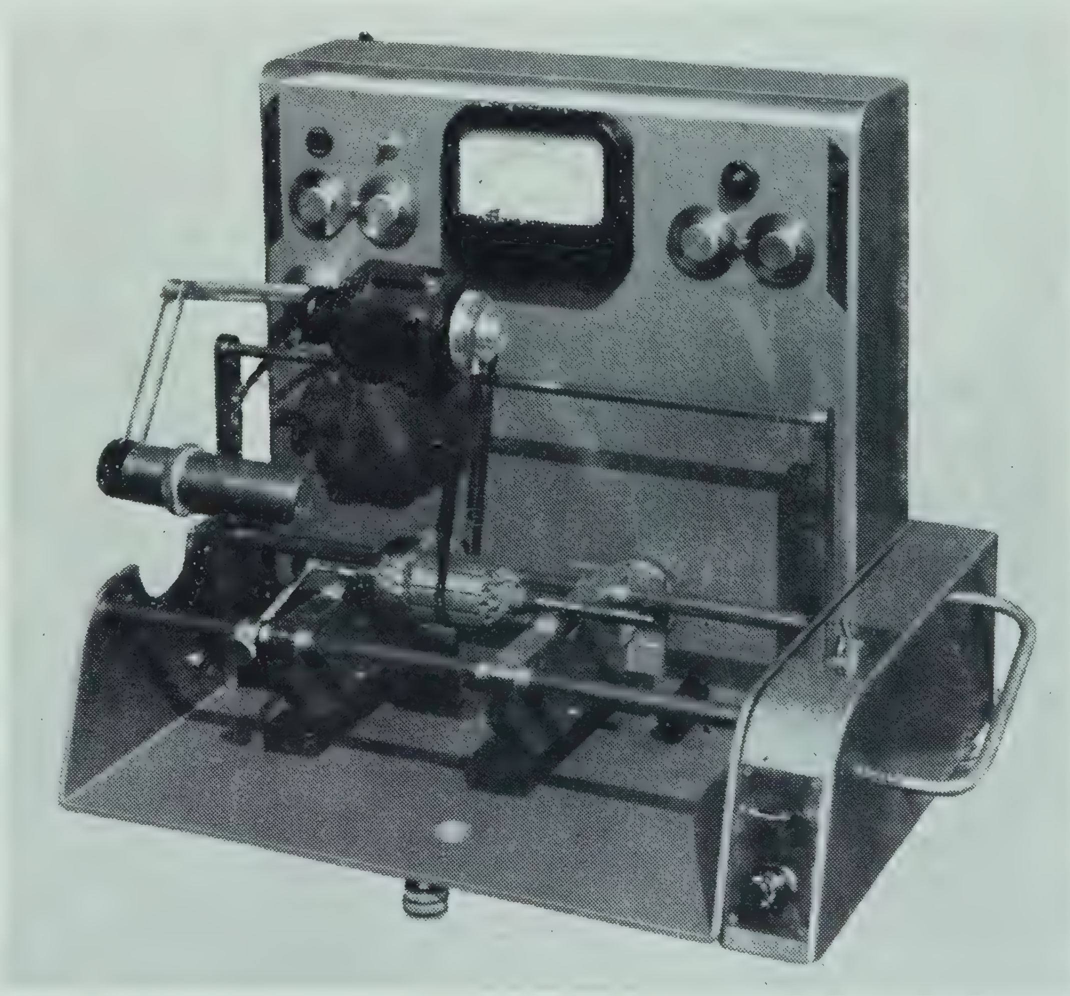


Figure 2. Dynamic Balancing Machine, Type 1250.

The bearings are flexibly supported and connected to moving-coil pick-ups which generate alternating voltages proportional to the unbalance.

These voltages are amplified, filtered and indicated by a meter, the calibration of which can be set to read in drilling depths, or weights of added material. The angular location of the necessary correction is shown by a stroboscopic lamp.

A left-right switch is provided for taking readings from either end of the rotor in planes which are preset to coincide with convenient portions of the body to which material may be added or removed.

Special features of the new machine are the high sensitivity (an unbalance of 0·005 gm.cm. is easily indicated), easy accessibility of the electronic unit, improved layout for the controls and provision for operating the drive motor by a foot switch so that both the hands are free.

Strobotuner Type 1204†. An electronic apparatus to assist in the rapid and extremely accurate tuning of pianos and reed and brass instruments, entirely eliminating the errors of the conventional aural methods. A gaseous discharge tube flashes in accordance with the sounds reaching a microphone, and its light illuminates a series of twelve rotating discs. Each of these discs carries seven stroboscopic rings of alternate black and white segments. Each ring, progressing radially, has twice as many segments as the preceding one. When the number of light pulses per second is the same as the number of dark segments passing per second on some ring on one of the discs, that ring will appear to stand still.

The twelve discs correspond to each chromatic note in the seven octaves marked on each disc, making a total of 84 notes.

The speed ratio between adjacent discs should be that of the equally tempered semitone, that is, the twelfth root of 2. It is impossible to obtain this irrational ratio by any finite numbers of gear teeth. However, by the use of carefully chosen gear ratios in alternation an exceedingly close approximation to true equal temperament is obtained, the maximum error being 0·12 per cent.

The discs are driven from a synchronous motor whose power supply is obtained from a valve maintained fork, the frequency of which can be varied half a semitone each side of the nominal by sliding weights, thereby providing a continuous frequency coverage from 32 to 4070 cycles per second.

The resulting high accuracy and instantaneous frequency indication means that the instrument is particularly suitable for production line testing of musical instruments.

High Speed Level Recorder Type 1406†. An automatic audio-frequency measuring apparatus for recording response characteristics on linear or logarithmic scales. It is specially suited for recording rapid signal level variations over a wide range for such applications as microphone, amplifier and loudspeaker frequency characteristics, also reverberation periods and intensity variations with time. A special feature of the apparatus is the rapid writing speed amounting to full traverse of the chart in about one tenth of a second.

The model demonstrated is a production version of the experimental model shown last year, incorporating various detailed refinements.

High Speed Counter Type 101A†. A panel mounting six-digit electromagnetic counter with re-set action for rates up to 600 per minute and with a life of at

least 10,000,000 counts. The unit employs a laminated iron circuit and pivoted rotor similar to that used in an electric motor. This provides a balanced construction with minimum wear on the moving parts.

Sound Level Meter Type 1400C†. The Sound Level Meter Type 1400C embodies all the facilities provided by the normal type of equipment, namely, 34-130 db. range, selected weighting networks, speed of meter response variable, but by the use of miniature components and careful design, the volume and weight have been reduced by approximately one half, inclusive of self-contained batteries, thereby achieving a really portable equipment.

Figure 3. "Q" Meter, Type 623A.

"Q" Meter Type 623A† (Figure 3). A Resonance Type "Q" Meter for use over the frequency range 25 to 200 Mc/s.

The injected voltage for the Q circuit is developed across a compensated series inductance of exceedingly low value which forms part of one of the test terminals, thereby reducing errors which would be inevitable with the usual series resistance method.

A worm-driven condenser of low inductance construction is used for the Q circuit. It is direct reading with an effective scale length of $5\frac{1}{2}$ inches providing excellent discrimination on high Q values.

Distortion Factor Meter Type 700C† (Figure 4). An entirely new circuit design has enabled the frequency range of this instrument to be extended and the operation considerably simplified. The frequency range 20 c/s. to 20 kc/s. covered by a resistance-capacity rejector circuit, which is included in an amplifier with a negative feedback circuit, ensuring that the second harmonic is not attenuated by the filter. The valve voltmeter is capable

of measuring up to 100 kc/s. i.e., the fifth harmonic for 20 kc/s. fundamental. The total harmonic distortion over the range 0·1 to 50% is measured in two ranges and the rejection filter is directly calibrated in frequency.

Figure 4. Distortion Factor Meter, Type 700C.

Gas Detector and Sentinel Type 2010A†. The instrument comprises a detector unit employing a Wheatstone Bridge with a heated catalytic filament in one arm and an alarm unit, both operating from self-contained batteries.

The feature of the design is the great economy in battery consumption, which is achieved by automatically switching the bridge into circuit for ½ second only in each 5 minutes. By this means the self-contained batteries provide a working life of 240 to 300 hours. The complete equipment has a lower limit of sensitivity of approximately 0·5% coal gas in air or 0·2 to 0·3% (by volume) petrol vapour in air.

Wide Range Oscillator Type 400†. An improved design with a new type of resistance-capacity frequency determining network. A 3-gang resistor is used for the main calibrated frequency control and is combined with a switched condenser for range multiplication. The relatively low impedance of the network enables a much improved degree of frequency stability to be obtained compared with the more usual circuit employing a low capacity variable condenser and high value fixed resistors.

An additional advantage is the improved scale shape obtainable on the frequency control. The low distortion characteristics and constancy of output amplitude achieved in the previous version of the Series 400 oscillators has been maintained on the new design.

Stand 78

GAMBRELL BROS. & CO., Ltd.,
A.G.I. Works, Purley Way, Croydon, Surrey

Standard Potentiometer†. A four-dial potentiometer of the highest accuracy. The design is such that there are no switches or moving contacts in the current carrying part of the circuit in which the potential is generated ; this ensures that the high initial accuracy is maintained indefinitely. Also when the dials are set at 0 there is no measurable potential. The range of measurement is from 0 to 1·9 volts, the first dial having 18 steps each of 0·1 volt, the second dial 10 steps 0·01 volt, the third dial 10 steps 0·001 volt and the fourth 10 steps each of 0·0001 volt. The circuit is arranged so that the resistance in circuit with the galvanometer is constant at any setting of the potentiometer, so that final readings can be taken on the galvanometer scale. A control is fitted to the galvanometer so that its deflection can be adjusted to a convenient value for easy reading. A second pattern can be supplied in which the last dial consists of a robust slide wire, divided into 120 divisions, each of which corresponds to 10 microvolts. Readings can be estimated to 1 microvolt. The circuit is arranged so that if a small potential be generated due to rotation of the slide wire contact, the accuracy of the instrument is not affected. Adjustment is provided for the temperature variations of the standard cell. High and low sensitivity galvanometer keys are provided. Both types of potentiometer are suitable for oil immersion.

Strain Gauge†. This gauge is designed for recording the relative movements in large metal surfaces. The record is made on a celluloid strip. Special arrangements are made for holding the recording equipment on to the metal surface.

50 Megohm Standard†. A highly accurate resistance standard in which the construction and materials utilized have been very carefully considered in order to obtain a very high insulation across the resistance and to the screen. The screen is of special design and protects the insulation. A high degree of stability is obtained.

Precision Slide Wire†. The wire is wound on a rigid drum of cylindrical form and has a length of approximately fifty feet. There are 100 turns. Each turn is divided into 100 parts indicated by a rotating dial, the number of turns in use being shown by a second dial. The wire used is specially drawn and possesses a very high degree of uniformity.

Educational Instruments.

Metre Bridge†. The slide wire of this bridge is of circular form on a panel approximately 14 in. square. Terminals for the usual four gaps are fitted. The size of this instrument is far more convenient than the old type of metre bridge, and is therefore less liable to damage.

Wheatstone Bridge†. A four-dial bridge in which the series dials and ratio arms are all switch controlled to replace the conventional plug bridge, the main advantage from an educational point being that there are no loose parts. Accuracy is to within 0·2%.

Differential Galvanometer†. This galvanometer has been designed for educational purposes. A large window enables all parts to be easily seen. The moving coil is fitted with a differential winding which enables a large number of additional experiments to be carried out. Reflector and pointer types are shown.

Stand 79

W. G. PYE & CO., Ltd.,

"Granta" Works, Newmarket Road, Cambridge

Precision Vernier Potentiometer† (Cat. No. 7568). This is a three-dial potentiometer with a range of 1·901 to 0·00001 volts. A built-in range switch extends this to 0·000001 volt. The three direct reading dials are divided to 18 steps each of 0·1 v., 100 steps of 0·001 v. and 101 steps of 0·00001 v. Accuracy is to within 0·001% or 1 part in 100,000 at the 1 volt setting. Great care has been taken to minimize thermal effects which under normal conditions are less than 1 microvolt. Thorough arrangements are made for standardizing and temperature correction. A switch selects any one of three external circuits.

Universal Portable Precision Potentiometer† (Cat. No. 7565P). This is an entirely self-contained potentiometer with built-in taut-suspension galvanometer and scale, presented in a polished hardwood case with carrying handle. The direct reading range is from – 0·0001 volts to + 1·75 volts. Range multipliers of 0·1 and 0·01 extend the range down to 1 microvolt. Provision is made for accurate standardizing against a built-in Standard Cell. A 2-volt non-spillable accumulator and battery for the lamp are included. A three-way switch selects any one of three external circuits.

Pye High Resistance Bridge†. The bridge is designed for the accurate measurement of high resistance by direct current; the maximum operating voltage when measuring resistors above 10,000 ohms is 150 volts. Adequate sensitivity for lower values of resistance can be obtained with greatly reduced voltage.

Specification. Direct reading range 10 ohms to 1·1 megohms. Extreme range (using ratio dials) 0·01 ohm to 1,000 megohms.

All coils are wound with carefully aged manganin, suitably impregnated.

Accuracy. Standard: to within ±0·02%; Special: to within ±0·01% at extra cost.

Description. This is a Decade Type Wheatstone Bridge having two ratio dials, each with four steps of 10, 100, 1,000 and 10,000 ohms respectively. The known or bridge arm comprises five decades, each in ten steps of tens, hundreds, thousands, ten-thousands and hundred-thousands respectively. Additional decades can be connected between the bridge arm series terminals to extend the direct reading range of the bridge. The bridge arm may also be used independently as a Standard Decade Box by connecting to the terminals marked 'Series.' The usual terminals are provided for the battery, galvanometer, and test resistance to be connected to the bridge. All decade switches are our new improved type, and all brush gear and contact studs are mounted underneath the bridge panel. The bridge is

enclosed in a polished wooden case with hinged lid. Detailed operating instructions and a circuit diagram are supplied with each instrument. Special precautions have been taken to reduce errors due to insulation leakage and creepage to an absolute minimum. It is recommended that when using the bridge, the batteries and galvanometer be placed on sheets of insulating material (e.g., alkathene or distrene).

Galvanometers. A complete range is shown comprising freely-suspended, taut-suspended, reflecting and pointer models in a variety of sensitivities and types for research and educational use.

"Scalamp" Galvanometers† (Figure 1). Self-contained galvanometer complete with taut-suspension moving-coil unit, scale, lamp, transformer and A.M. shunts giving five different sensitivities. This is an entirely new model in a moulded Bakelite case designed substantially to reduce production costs without impairing the high performance of the original model. Efficient anti-vibration feet are fitted allowing the instrument to be used on normal working benches. The resistances of the shunts have been chosen to provide critical damping over a wide range of circuit conditions and together with the short period make the galvanometer a pleasant instrument to use.

Figure 1.

Ultra Short Period Galvanometer† (Cat. No. 7966). The period of this Galvanometer is measured in milliseconds, the moving coil being similar to that described by Professor A. V. Hill in the *Journal of Scientific Instruments*, July 1948. Typical performance figures are as follows : period : 10 msec. ; sensitivity at 1 metre : 1·5 mm/μa ; resistance : 48 ohms ; critical damping resistance : 100 ohms. We have found it convenient to couple the galvanometer to a cathode follower valve when using it in conjunction with a photographic recorder (such as the Matthews Low Speed Recorder made by Clifton Instruments Ltd.) The figure of merit is very favourable with comparable types of galvanometer. The suspension is robust and not readily damaged.

Multi-Purpose Precision Switches. A.218 Series†. A few of our wide range of these newly developed precision switches are shown. These are of the rotary type with a positive clicker and assembled on a high dielectric Bakelite moulding. The overall diameter is $3\frac{1}{2}$ in. and depth behind the panel $1\frac{3}{8}$ in.

Combinations available are : 5 pole 2 way, 4 pole 2 way, 3 pole 3 way, 2 pole 6 way, 1 pole 12 way. The contact spacing is 24° and units may be ganged. An 'off' position can be provided on some types at the expense of a slightly higher switch resistance.

Voltage rating is 500 V. D.C. Current rating is nominally 2 amp. but is dependent upon the arcing effect of a particular load.

These switches can be supplied with either beryllium copper or copper contacts.

Brush-to-contact resistance: beryllium copper 0·001 ohm, copper 0·0002 ohm.

When required for decade switching, spacers can be provided so that the coils or condensers may be accommodated between the switch and the panel.

Thermocouple Switches†. These precision leaf-type rotary switches are normally supplied with beryllium copper leaves and double-silver contacts.

They are particularly suitable for switching banks of thermocouples and are available in single pole types up to a maximum of 101 contacts, double pole types up to 50 contacts and multipoles pro rata. Thermo-electric effects have been reduced to less than one microvolt at normal room temperature.

Audio Frequency Oscillator†. With a coverage of 20–20,000 c/s. in three switched ranges and with built-in output meter this is a particularly useful instrument. The scales are individually calibrated, accuracy being within $\pm$ 1% below 100 c/s., $\pm$ 0·2% above 100 c/s. The total scale length is 20 ins. The output is adjustable with a maximum of 20 volts into 600 ohms. The total harmonic distortion does not exceed 1%, and the hum level is less than 0·2%. The frequency stability is particularly good.

D.C. Amplifier† (Cat. No. C.1043) (Figure 2). This amplifier is particularly suitable for vibration analysis, biological work, thermocouple recording, etc.; it has a total gain of approximately $7{\cdot}5 \times 10^5$ with a twelve point gain switch. At a gain of 100 db. the response is flat within $\pm$ 3 db. over the range 0–15,000 c/s. The noise level (referred to input) is approximately 6 microvolts. Two outputs are available: voltage at 170 volts peak to peak for operating a cathode-ray oscillograph, or current at $\pm$ 3·5 ma. for operating a meter or recorder of impedance not greater than 50 ohms. When operated from normal A.C. the mains drift is negligible after 2 to 3 hours and mains fluctuations over a very wide range are fully compensated for.

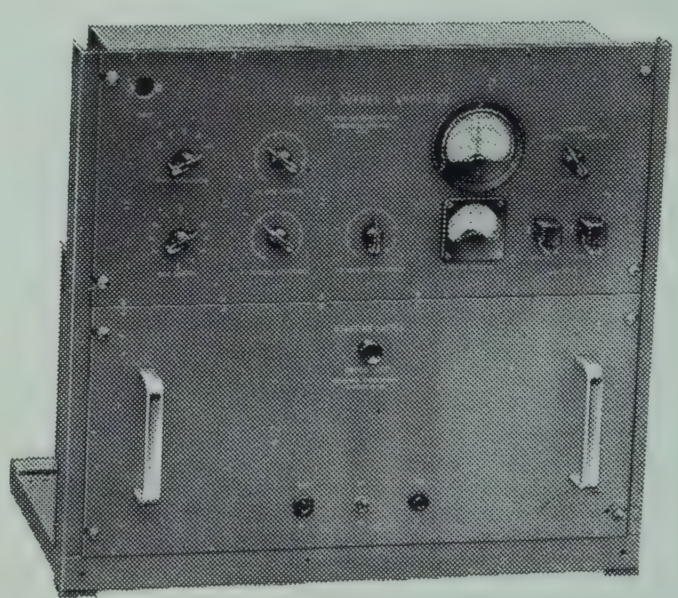


Figure 2.

Stabilized Power Pack†. This is very similar to the power pack built into our D.C. Amplifier. Models are available giving outputs of 250 volts at 180 milliamps or 250 volts at 325 milliamps. They are stable within 2 millivolts over a wide range of mains input fluctuations. The high current output enables the heaters of indirectly heated valves to be series connected and, with a suitable dropping resistance, supplied from the stable H.T. line.

'Cathodeon' Combined Pirani and Ionization Gauge†. The vacuum gauge unit is a small compact apparatus for measuring electrically low pressures over a wide range. The unit contains its own power supplies and meters, the

only external parts being the glass Pirani lamps and ionization gauge bulb, which are sealed directly into the vacuum system. A single multiplate switch enables readings of pressure to be taken either on the Pirani gauge or ionization gauge. On the former, pressure may be read from 1 mm. down to 10^{-3} mm. of mercury and on the ionization gauge from 10^{-2} mm. down to 10^{-6} mm. of mercury. Provision is also made to bombard the interior structure of the ionization gauge to degas the electrodes of the gauge.

CLIFTON INSTRUMENTS Ltd.,
80, Newmarket Road, Cambridge

Matthews Low Speed Recording Camera†. The camera may be used to record the deflections of a light beam controlled by the mirror of an oscillograph or any similar device. The record is made on photographic paper, and when developed is positive, i.e., a black trace on a white background. As the paper passes through the camera fine horizontal lines are marked on it at one millimetre intervals. The paper speed is 3 cm/sec. The motor which drives the paper also drives a time-marker and stroboscopic disc, which, when viewed by the light of a neon lamp excited by 50 c/s. mains, enables the speed of the paper and the time-marker to be adjusted with accuracy. Fine time marks are produced every 0·04 second, and heavy marks every 0·2 second. As the paper moves it operates a ‘ Footage Indicator ’ on the top panel which shows the length of paper remaining to be exposed. Provision is made for marking the edge of the paper with heavy horizontal lines ; any number up to four may be used as indicators for change of recording conditions. The knob controlling the indicator is on the top panel. A long focus cylinder lens for condensing the light beam on to the camera slit will be found just inside the exposure door. For electrical recording the ‘ Pye ’ Short Period Galvanometer (10 millisec.) or the Matthews Mk. II Oscillograph are very suitable for use with this unit.

Matthews High Speed Recording Camera†. This is a drum type camera giving film speeds variable between 30 and 60 inches per second (75 and 150 cm. per second). The large drum is driven by a powerful spring motor mounted on a cast aluminium stand and an automatic shutter mechanism incorporating a high power cylindrical lens. The sensitive film or paper is fixed on to the drum and the shutter so arranged that when the release is operated, it only remains open for one complete revolution of the drum. Any width of film or paper up to 4 inches (10 cm.) wide and any length up to 3 feet (90 cm.) may be used.

Matthews Oscillograph Mark II†. This instrument is an electromagnetic type having four coils, each of which is used in series with a high impedance pentode valve so that the electrical speed of the system is higher than the free vibration frequency of the moving system which is of the order of 4,500 c/s. The use of special magnetic alloys, combined with the design of the moving system, ensures freedom from errors due to hysteresis. If maximum speed of deflection is not required, the coils may be connected in series and used in the anode circuit of a single pentode valve. A $\frac{1}{4}$ in. $\times$ 1 metre focus concave mirror is fitted, giving exceptional illumination and sharpness of image. The working deflection is 4 cm. at 5 metres, and is linear for 2 cm. on each side of zero.

Stand 80

NEGRETTI & ZAMBRA Ltd.,

122, Regent Street, London, W.1

As this year is the Centenary of the Royal Meteorological Society, and incidentally of this company, it is thought appropriate to show a selection of meteorological instruments together with a model meteorological station.

STANDARD BAROMETERS†.

There are two main types of standard mercurial barometers, viz., the Fortin and Kew patterns.

The **Fortin Barometer** measures the actual head of mercury from a fixed datum point in the cistern. Before readings are taken, it is necessary to adjust the level of mercury in the cistern to the fixed datum, consisting of an ivory point. This adjustment serves the double purpose of raising the mercury until it is in contact with the ivory point, and of rendering the instrument portable by entirely filling the tube and cistern with mercury.

The mercury is contained in a boxwood cylinder with a leather bag at its lower end and a glass cylinder at its upper end. The adjustment screw raises or lowers the level of mercury in the cistern, and the level of mercury can be adjusted with precision to the ivory point.

The **Kew Barometer** measures the head of mercury direct, without any adjustment of the cistern level. The cistern is of cast iron, and in the calibration of this Barometer, allowance is made for the rise and fall of mercury in the cistern.

Both types of barometers require corrections for index or scale errors, temperature, latitude and reduction to sea level.

Precision Aneroid Barometers. The quality and performance of diaphragms used in aneroid barometers has a very important bearing on the accuracy of the instrument.

Negretti & Zambra's method of stamping diaphragms, instead of spinning them in the usual way, produces diaphragms of very high consistency in their performance and of considerably higher quality than has hitherto been possible.

Hardened and tempered steel or nickel silver alloy is used, and the diaphragms are formed — without the use of any springs — into one complete unit.

As the result of prolonged investigations and research, Negretti & Zambra have established a design of aneroid barometer which is probably the most notable advance made in aneroid design. The inherent errors have been reduced to such small proportions that this aneroid barometer might well replace the mercurial barometer for scientific observations, since it requires no corrections for temperature or latitude.

Errors due to *temperature* changes occur only in a minor degree from the thermal expansion of the various members, and are mainly due to the physical property that materials have of a change of elasticity modulus with temperature.

By suitably proportioning the volume of the space inside the boxes when closed to that when open, and by leaving a certain definite amount of dry air in the boxes, a compensation varying with the deflection is effected.

This method of compensation, together with the improved method of construction of the diaphragms and their connections, ensures practically perfect *compensation for temperature* over the whole range of the instrument.

The movement employs two sets of four exhausted diaphragm capsules ; each set consists of eight nickel-plated hardened and tempered steel diaphragms. The two sets are fixed to the frame of the instrument, and the free ends are connected to a magnifying lever in such a manner that the two sets are balanced. The magnifying lever is of girder construction, and the fulcrum is formed by a flexing strip of stainless steel. The diaphragms are also connected to the balancing lever by flexing strips. At the end of the magnifying lever the movement is magnified, and at this point the movement is unaffected by position and balance, and is free from friction or backlash. The control is considerable, due to the number of diaphragms used. The end of the magnifying lever is then linked to a second lever mounted on a practically frictionless spindle with point bearings. Attached to this spindle is a third lever which operates a chain and pulley mechanism. The pulley is of large diameter and operates on a spindle with a thrust bearing. A hair spring is used to give the required tension on the chain.

Barograph (Recording Barometer), British Meteorological Office Specification. The movement consists of 7 to 8 chambers of spun diaphragms with inside springs. The case is of mahogany, french polished, with dovetailed corners, and the front and left-hand side of the case is glazed; a stout handle is secured to the lid. For time marking a spring push is fitted into the cover to depress the recorder arm at the right-hand end, the push-knob being flush with the mahogany. A drawer is fitted to the bottom of the case to hold a spare pen arm. A stoppered bottle for ink is sunk into a socket in the baseplate, with a brass dipper. The range is from 950 to 1050 mb. The barograph is fitted with a weekly drum.

Precision Recording Barometer, or Micro-Barograph. A recording barometer with a greatly magnified scale, showing that fluctuations of pressure of the order of 0·02 in. may be faithfully recorded, is required in the investigations of various meteorological phenomena, and in the tropics where the movements of the barometer are practically only those of diurnal variation of the order of a few tenths of an inch. Further, such an instrument is indispensable in air surveys for recording the barometric changes at the base.

A magnification of five times normal scale cannot be effected by the ordinary type of barograph, for the reason that there is not sufficient control to overcome the friction of the moving parts of the pen on the chart, etc., nor can temperature corrections be arranged to the necessary fine degree. Therefore, in this precision barometer, four sets of the special diaphragms are used in two pairs, thus achieving the desired end in giving adequate control on the pen arm. Their movement is transmitted to the main lever through flexing strips, thus avoiding the use of pivots, then by a crank slotted link to the pen arm.

'Natural Syphon' Rain Gauge†. This is a type of gauge which automatically syphons after each 0·5 in. of rainfall, and does not require hand operation of the syphon. The rain is collected in a 6 in. diameter funnel and is led through a pipe to a float chamber, where it is recorded by a float mechanism. As the float rises,

the pen attached to the float rod traces the record on a clock-driven chart. When the pen reaches the top of the chart for 0·5 in. of rainfall, the syphon automatically comes into action and discharges the gauge rapidly. The pen falls to the bottom of the chart and the cycle is repeated.

'Campbell-Stokes' Sunshine Recorder†. The instrument consists of base-plate, standard, semi-circular arc, brass casting for holding the recording cards generally known as the bowl, and a glass sphere.

The base is a heavy polished slate slab.

The standard is a brass upright, with plate and clamp for fixing the arc at the correct latitude.

The semi-circular arc, which carries a graduated scale of latitudes, has bosses at each end accurately drilled and tapped to take the securing bolts and locking nuts for the sphere.

The bowl is machined with three concentric grooves to take the three patterns of cards as follows :

Equinoctial (Straight)	..	width	1·56 in.
Summer (Long Curve)	..	,,	1·26 in.
Winter (Short Curve)	..	,,	1·26 in.

The edge of the bowl should be cut so that when it is adjusted for its mean latitude, the plane of the cut shall be approximately horizontal.

The sphere is of well-annealed glass, of refractive index 1·512. The focal length is 2·95 in. and the diameter 4 in.

Thermometers

These include the maximum thermometer ; minimum ; solar maximum and registering thermometer ; earth thermometer ; 'ordinary' thermometer ; 'standard' thermometer.

Deep Sea Thermometer. The Negretti & Zambra original patent 'Reversing' or 'Turnover' pattern indicates the temperature only *at the spot where it is reversed.*

The action is that when it descends into the sea it acts as an ordinary thermometer, the mercury rising and falling according to the temperature of the stratum through which it passes. When, however, the prearranged depth is reached, and a reverse motion given to the line to pull the apparatus to the surface, the column of mercury breaks automatically, and that which is cut off at the constriction or appendix remains to indicate the actual temperature at the moment of reversal at the prearranged depth.

The thermometer consists of a tube and bulb made of glass of known constants, such as Borosilicate, of a length suited to the range of scale and graduations as described later, and with two cavities, of which the lower is to accommodate surplus mercury if the thermometer is heated above the scale value. The upper cavity takes the surplus mercury when the thermometer, after reversal, passes through layers of water at a temperature higher than that at the reversal. This surplus must not fall and join the main column or it would falsify the reading, and therefore the tube is made so that it will hold the maximum amount which may expand during any one sounding. The latest type of cavity takes the form of a loop, which adds great strength to the thermometer where it is most needed.

Various forms of constriction have been tried, but that which has, up to now,

met with the greatest success, is in the form of an appendix which is visible upon all N. & Z. deep sea thermometers. Upon reversal, the mercury starts to flow from the point of the appendix and then breaks at the point where this joins the main column. Experience shows that this form of 'break' gives the most exact reproductions of readings, which is, of course, the vital point of a reversing thermometer.

The bulb and stem are protected against pressure effects up to *at least 3 tons per square inch* (470 kg/cm^2) by an outer glass sheath with mercury round the bulb to conduct changes of temperature rapidly to the thermometer.

Standard Hygrometer, British Meteorological Office pattern to B.S.I. Specification 692 – 1936. The tubes are protected by outer glass sheaths; overall length is 12½ in. The bulbs are of normal glass, with stems of British lead glass supported inside the sheaths by rings of rubber; the sheaths are permanently fused on to the thermometers at a point between the bulbs and the lowest graduations. Range: 0° to 130° F. or –15° to +115° F. divided on the stems in single degrees and figured every 10° F. The wet bulb is supplied with muslin and wick, and there is a glass water reservoir with bronzed brass bracket.

Note.—In the use of wet and dry bulb hygrometers, the muslin must be clean, and should therefore be changed before it becomes dirty. The water used must be soft, either distilled or rain water.

The Bimetallic Thermograph is used extensively in cold-storage plants, factories, mines, heating and ventilating systems, etc., for recording on a chart the air temperature conditions.

It is one of the simplest instruments for recording temperature. The mechanism consists of a helix of bimetallic metal, which coils and uncoils with changes of temperature, thereby operating a pen recording on the typical clock-driven chart. The control is amply sufficient to overcome any friction of the pen and the scale value is constant for even increments of temperature.

Earth Temperature Recorder. This is constructed on the Negretti and Zambra patent mercury-in-steel principle, the bulb is of steel of small diameter and 10 in. or more in length, coated with lead for protection against corrosion; it is buried horizontally in the ground at the depth at which temperature records are required.

This method of obtaining earth temperatures is one of great precision and much more convenient than taking the readings by means of mercury-in-glass thermometers.

The capillary is also lead-coated to withstand the corrosive effect of chemicals in the ground. It may be any length up to 100 feet, and the standard instrument is supplied with 15 feet of capillary.

The Recording Hair Hygrometer gives a direct record of humidity without reference to tables.

The hygroscopic element consists of a number of specially treated human hairs, which lengthen and contract with the variations of moisture in the atmosphere. The hairs are contained in a well-ventilated brass tube, the top end being anchored to an adjustable screw.

The other end of the hairs operates through a connecting link to a crank on the pen arm spindle.

The design necessitates unequal spacings on the chart, but offers the great advantage that all levers, gears, cams, etc., are eliminated and the hairs are coupled up directly to the pen arm.

The Thermo-Hygrograph records on one chart the changes in both *temperature and humidity* under atmospheric or automatically controlled conditions.

The thermometric element is a bimetallic spiral coil, and the pen records on the upper part of the chart.

The hygrometric record is obtained from the action of human hairs, and is on the lower part of the chart.

The total height of the chart is 7 in. The pen arm and movements, situated well away from the case, are protected by a stout wire frame.

Stand 81

E. K. COLE Ltd.,
Electronics Division,
Malmesbury, Wilts.

Radioactive Thickness Gauge†. A thickness measuring gauge suitable for use with materials of all kinds. The demonstration shows the gauge as it can be used in an industrial installation to measure and, with suitable additional equipment, control the thickness of strip material. DEMONSTRATION.

Radio-isotope Analyser†. A completely self-contained apparatus for the accurate measurement of Radioactive Isotopes, using a methane flow counter, Linear Amplifier 1008A, Scaler 1009A, Power Unit 1033A and Cathode-ray Oscillograph 1089A. DEMONSTRATION.

Scaler 1009A†. (Figure 1). An equipment capable of counting up to 40,000 counts per minute using 2 electronic decades, followed by a mechanical Register. The input resolution time is 1·5 microseconds pulse height discrimination and paralysis facilities are provided and the D.C. power supplies are fully stabilized.

Figure 1. Scaler 1009A.

Linear Amplifier 1008A†. This is a general purpose A.C. Amplifier, consisting of a main amplifier unit and two head amplifiers, either of which may be used according to requirements. The maximum overall voltage amplification is 1,600,000 and this is constant within 3 db. over the frequency range 20 c/s. to

500,000 c/s. The noise level is low enough to permit useful amplification of signals of the order of a few microvolts and the stability is to within 1%.

The main amplifier unit contains all power supplies and has the amplifier itself resiliently mounted to minimize microphony. Circuits which may be adjusted to give various differentiating and integrating time constants are provided to enable the most suitable bandwidth to be selected.

Power Unit 1033A†. This Power Unit is expressly intended to energize all types of counters used in Nuclear Physics, including scintillation counters.

It is of the H.F. oscillator type with a specially designed feedback amplifier for stabilization. Careful design ensures that ripple and spurious pulses are reduced to such a level that external filters are not normally required.

The output voltage is continuously variable from 500 to 3,000 volts. It is virtually unaffected by mains variations up to $\pm$ 10% and normal temperature changes. Accuracy and stability are of an exceptionally high order.

This Power Unit is an improvement on other commercially available equipments and may be used with confidence wherever a highly stable voltage is needed.

Ratemeter 1037A† (Figure 2). This is a general purpose Ratemeter with a self-contained high voltage supply, suitable for polarizing Geiger-Müller tubes, etc. It gives a direct and almost instantaneous reading of the mean repetition rate of incoming pulses up to a maximum of 100,000 per second. Pulse height discrimination and paralysis facilities are provided and a suitable external recorder may be used as desired. An amplifier for use with G-M tubes is included.

Figure 2. Ratemeter Type 1037A.

Radiation Monitor 1043C† (Figure 3). The instrument is a completely self-contained and portable ionization chamber type radiation monitor, suitable for the measurement of Gamma-dosage, and for the qualitative detection of Beta-radiation. It is particularly suitable as a Health Monitor, and for general laboratory monitoring.

For Beta-detection a thin window in the chamber end wall is exposed by rotating an external metal flap. All batteries are built-in, the filament cell being directly accessible from the top of the instrument, the remainder being located in the pistol grip. The instrument has 2 ranges, the full scale readings being 0·125 and 1·25 roentgens per hour. It is manufactured to an A.E.R.E. design.

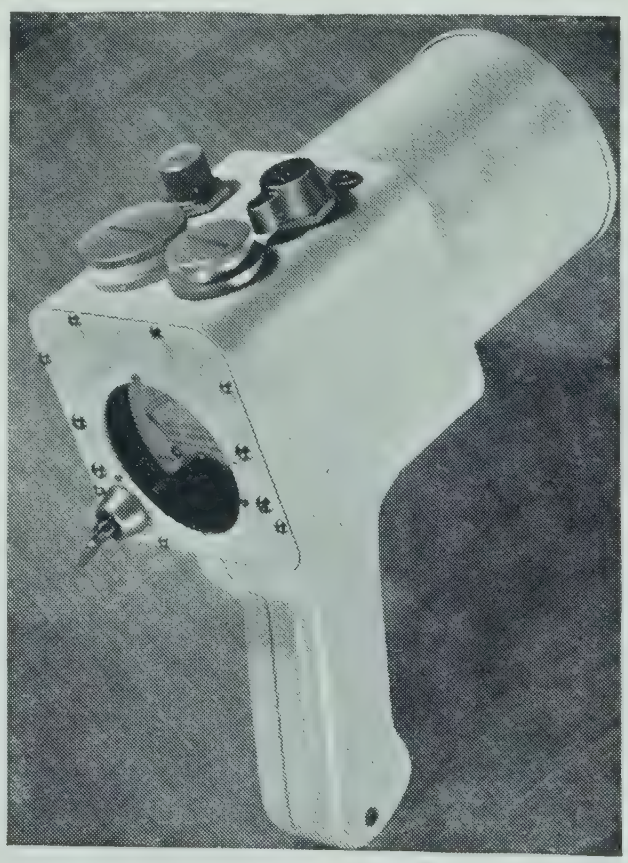


Figure 3. Radiator Monitor 1043C.

Radiation Monitor 1118A†. This monitor is identical in purpose to the 1043C but has a longer ionization chamber and a more sensitive electrometer tube. The two ranges have full scale readings of 15·0 and 150 milliroentgens per hour. DEMONSTRATION.

Radiation Monitor 1132A†. This monitor is similar to the type 1118A, but is designed for use with X-rays and will give accurate indication of dosage of very soft radiation. The ranges are 0–15 and 0–150 milliroentgens per hour.

Cathode-Ray Oscillograph 1089A†. This is a simple Cathode-Ray Oscillograph using a 3½ in. tube. It is primarily intended for monitoring the pulse wave forms met with in nucleonic investigation, but is equally useful wherever a general purpose cathode-ray oscillograph is needed.

Most of the provisions of a normal cathode-ray oscillograph are contained in this instrument except that there is no built-in 'X' Amplifier. Used with the Ekco Linear Amplifier type 1008A it has a deflection sensitivity and frequency response considerably better than the normal general purpose cathode-ray oscillograph.

Vibrating Reed Electrometer 1079C†. (Figure 4). A replacement for most forms of Valve Electrometer having a greatly improved zero stability as compared with other types. It consists of two units, the Head Amplifier and the Main Amplifier. These are connected by cables which may be up to 125 feet in length. The applied D.C. is converted into A.C. by means of a vibrating condenser, the A.C. is amplified and then rectified. Stability is increased by the application of negative feedback. Direct indication of the voltage or current being measured is given on a 3½ in. panel meter and simultaneously a recorder and/or a process controller may be operated.

Figure 4. Vibrating Reed Electrometer 1079C.

This Electrometer is expressly designed for ionization current measurements. Many problems involving the measurement of small direct currents and voltages can be solved with this instrument, including those associated with pH measurements.

The above units have been developed in conjunction with the Atomic Energy Research Establishment, Harwell.

A range of isotope containers, lead castles, screening blocks, and Geiger-Müller tubes is also on display.

Stand 82

EVERETT, EDGCUMBE & CO., Ltd.,
Colindale Works, London, N.W.9

The Everett Edgcumbe display will, as usual, be devoted to developments made during the past year in electrical measuring instruments of both indicating and graphic types.

Progress in instrument design for many years now has been marked more by changes in detailed construction and production methods than in actual fundamentals, but mention should be made particularly of the new designs of movement now available, both in moving-coil and moving-iron patterns. In general, these new designs are due to the great improvements and developments in magnetic materials.

For instance, the latest Everett Edgcumbe Long Scale (270 degrees) Moving-Coil movement embodies several small block magnets of the aluminium-nickel-cobalt class, distributed round the air gap in which the moving coil moves. This ensures not only a much greater field strength than used in any other contemporary design of long scale instrument, but also provides an even distribution of flux throughout the length of the gap.

This design is now available in all sizes of indicating instruments from normal 8 in. diameter down to 2 in. diameter. The speed of response and excellent damping of this movement will be demonstrated. For those who prefer a long scale instrument, it provides a means of indication which can easily and quickly be read and which responds without appreciable overswing to all changes in current in the circuit.

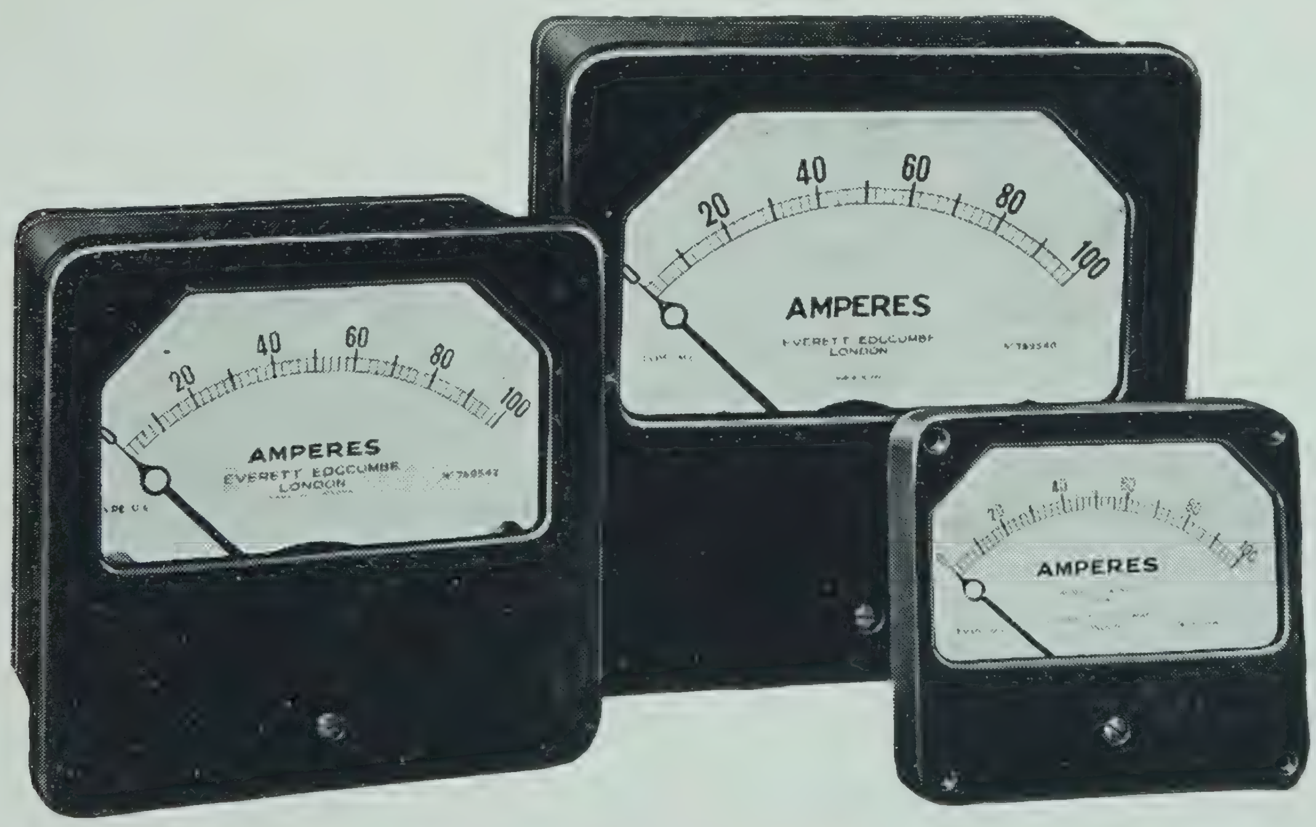


Figure 1.

A valuable adjunct to this design is the Super-Responsive ' Inkwell ' Grapher now widely used for high speed recording of rapidly changing electrical quantities. As in the case of the long scale indicating instrument, this ' Inkwell ' Recorder can have a response time of as low as 100 milliseconds. The pen will move over

the 4 in. wide chart in this time from zero to full scale without any overswing, provided the circuit constants are correctly chosen.

It is worth mentioning also that progress has been made in the housing of all types of instrument movement, including Ammeters, Voltmeters, Wattmeters, Frequency Meters, Power Factor Meters, Synchroscopes and also Electric Clocks and Timing Devices in square or rectangular cases of pleasing appearance with both protected and open fronts. These designs, which are perfectly plain and have no decorative features likely to collect dust, range in size from 3½ in. to 6 in. scale, as shown in Figure 1.

Coloured cases and tinted scales have been supplied in these patterns for schemes where the normal black and white appearance might lead to fatigue of an observer.

The following brief notes refer to other specific instruments which will be exhibited.

New Speed Recorder†. This has been designed to record directly the average speed of a train or similar moving object over a measured length of track. The instrument is operated from two track switches, one at each end of the measured base length and is energized from a 12 volt battery. Operation of the first switch initiates the timing period which is concluded when the second switch is operated. The second switch at the same time energizes the recording circuit on the instrument which is of the normal 'Inkwell' moving-coil pattern.

The pen on this instrument thereupon draws a line on the chart, the length of which is proportional to the speed of the train. The chart and the scale of the instrument are evenly divided and marked in miles per hour, the ratio between highest and lowest recording speeds being of the order of 10:1. Thus, for general railway work, it would be calibrated 0–100 miles per hour.

Provision is made by suitable design of the electrical circuits to ignore all impulses after the first one received and also to reset the equipment to zero, should the cycle of operations be incomplete due to a vehicle becoming stationary within the measured length.

The timing element is a heavy duty Precision pattern vibrator, driving a Synclock miniature synchronous motor, which in turn drives the potentiometer for the electrical recorder. The circuit is of a special compensated pattern with constant voltage transformer and provides a fixed voltage reference for the Graphic instrument. The effect of normal variations in the 12 volt secondary battery voltage is negligible.

A New Contact-making Voltmeter or Ammeter†. In order to reduce the size of this type of instrument, a new design has been evolved in the normal 3½ in. semi-flush case. The pattern embodies the best features of the contact ammeters and voltmeters which Everett, Edgcumbe & Co. have been making for about 40 years in the larger sizes of case. The contact switching capacity is of course limited and for operational controls, an interposing relay is required. As in the case of the larger contact instruments, provision is made for either one or two adjustable contacts, both of which can be moved quite easily over the scale, whilst the instrument itself operates as a normal indicator between the contact settings.

D.C. Transformer for Voltage Measurements†. Previous examples of this type of equipment have demonstrated its use as a current measuring device for

direct indication, particularly on heavy current systems of say 10,000 amperes and upwards. A recent development used on the electrification scheme of British Railways between Liverpool Street and Shenfield has applied this D.C. transformer to telemetering. In the particular scheme referred to, a D.C. voltage of the order of 80 volts, proportional to the current in the main D.C. feeders, was required for the operation of the telemetering circuits. A shunt in the D.C. feeder to give this voltage was of course out of the question, but the D.C. transformer fed from the local A.C. supply provided the ideal solution. Incidentally, a most important advantage was that the measuring and telemetering circuits were completely isolated electrically from the 1500 volt D.C. supply.

The example exhibited is for another railway electrification scheme, but, as shown, is providing a suitable voltage for the telemetering equipment from the 1500 volt normal D.C. voltage on the line. As mentioned previously, this enables the telemetering and indicating voltmeter circuits to be isolated from the high voltage. The same method can be applied with equal facility and utility to any D.C. circuit, for the insulation of the small transformer can be quite simply provided.

2 in. Disc Scale Moving-Coil Voltmeter†. This will be an example of the type of instrument referred to in the opening paragraphs.

Synclock Motors†. For the operation of timing processes, several new designs are now available with terminal shaft speeds different from those of the normal patterns, which have hitherto usually been 1 revolution per minute or 1 revolution per second.

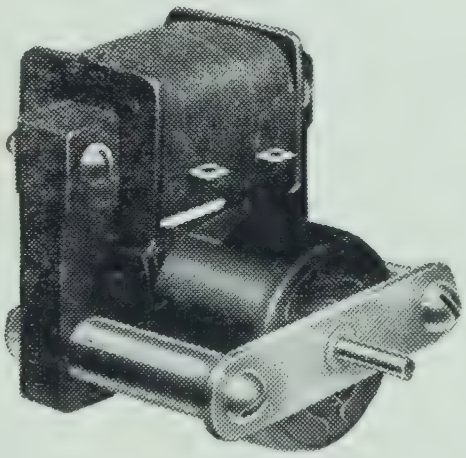


Figure 2. M.B. Synclock Motor.

The motor illustrated in Figure 2 is exactly the same size as the normal type B Synclock Motor (1 revolution per minute) but the gear box now contains further ratios in order to obtain a terminal shaft speed of 1 revolution per hour. The gear box is of similar design to that used for many years now and provides continuous lubrication for both shaft bearings and gears.

Technical improvements of construction have also enabled the pull out torque and running torque to be increased. This is particularly so in the case of the 1 revolution per second motor, where a new type, known as Type B.K., is rated at 90 gm. cm. at 1 revolution per second, when operating on a 50 c/s. supply.

The new types of Synclock Process Timers which are now available will not be shown at the Exhibition, owing to restrictions of space.

Portable, Multi-Range Electrostatic Voltmeter (10 kv.)†. This instrument can be used on both A.C. and D.C. circuits, the current drain being of the order of 10 microamperes. The instrument comprises a special Electrostatic

Voltmeter, mounted on a base of very high insulation resistance, together with a potential divider. The instrument has a $3\frac{1}{4}$ in. scale and is totally enclosed, special provision being made for range changing and for the accommodation of the test leads.

Two types are available :

Model B : 2, 4 and 8 kv.

Model C : 2·5, 5 and 10 kv.

High Frequency Voltage Transformers†. The example shown is a typical voltage transformer for use on the higher frequencies from 1,000 to 10,000 cycles per second. These transformers are intended for the operation of high frequency indicating instruments and relays. A demonstration of test gear for these frequencies will be made.

Indicating Instruments for Special Duty†. For use in situations where conditions are extremely arduous, several special features have been incorporated in some of the Everett Edgcumbe instruments. As an example, a 4 in. scale Square Flush Ammeter will be shown, similar in appearance to that on the left hand side of Figure 1. This will have a scale shape extended so that overload and starting conditions are indicated clearly. In order to do this satisfactorily, the damping torque of the movement has been carefully chosen, otherwise a false idea of starting currents might be given.

This instrument will, in addition, have a metal case with special panel gasket, toughened or armour plate glass sealed in and a sealed zero adjuster, not accessible from the front. Thus, it can be mounted on a control panel which can be cleaned or even washed down by unskilled labour without risk of damage to the instrument.

Stand 83

WESTINGHOUSE BRAKE & SIGNAL COMPANY, Ltd.,

82, York Way, Kings Cross, London, N.1

Westalite Rectifiers for E.H.T. Supplies†. The new range of Westalite metal rectifiers, operating at very high reverse voltages per element, shown for the first time last year, are now being widely used in television E.H.T. power supplies and also in photo-flash units. For television power supplies these units are now sold in sets for making up pulse multiplier units operating from line fly-back pulses, and for making up the Westeht multiplier to deliver E.H.T. from the power pack 350-0-350 volt transformer secondary winding. The sets for Westeht units include sizes particularly suitable for obtaining the E.H.T. for cathode-ray oscilloscopes.

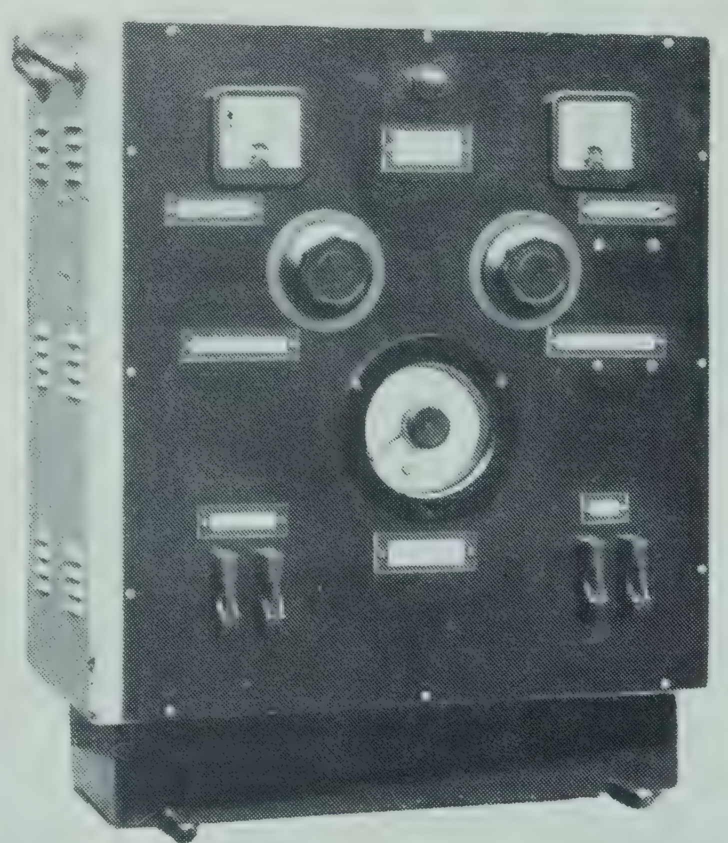
Westalite Units for Other Applications†. The popular trend in the lower-priced class of television receiver is to adopt the ‘ transformerless ’ type of power

pack, which requires two special arrangements of metal rectifiers. The normal H.T. rectifier is required to work with a very large reservoir condenser so as to secure the highest possible H.T. voltage from the rectifier, using a half-wave circuit direct from the supply mains. This requires the use of a rectifier having a specially low forward resistance, and the ability to withstand a current having a high peak factor. The H.T. voltage even then is insufficient for the line scan amplifier, and to secure additional H.T. voltage a further special rectifier is employed in the line damping circuit, the output of which is used in series with the main H.T. supply for the line scan amplifier.

A range of rectifiers developed for these two special applications will be displayed.

Westalite Rectifiers for Spark and Surge Suppression†. The use of rectifiers for absorbing the inductive energy in connection with relay and contactor circuits is quite old, but recently considerably more work has been done on this subject, and new circuits have been devised, in one of which the inductive energy, instead of being dissipated as heat, is used to charge a battery. In the case of equipment which is making and breaking rapidly, such as automatic telephone apparatus, such a procedure results in considerable saving of the size of rectifier to be used, as the rectifier no longer has to dissipate the inductive energy in the form of heat. The new, together with the older circuits, can readily be demonstrated using a telephone uni-selector switch as the source of inductive energy, and such a display is used as a working exhibit. DEMONSTRATION.

Automatic Control of Constant Current Density in Electroplating (see Figure). Many electrochemical processes such as electroplating and electropolishing only give the best results within reasonably close limits of current density. Very often the articles to be treated are of such shapes as to make accurate calculation of effective area difficult, and when mixed batches of work are plated at the same time, accurate calculation of area, and therefore of current to be used, becomes impossible. In the past it has been necessary to rely entirely on the judgment of the plater to decide the magnitude of current to be used with each batch of work being treated. To overcome this difficulty a controller has been devised to operate automatically a motor-driven regulator/rectifier combination to adjust the current automatically in proportion to the area of work being treated. This equipment operates by measuring the electrical characteristics of the vat load, and regulating the magnitude of the current accordingly.



Automatic control of constant current density in Electro-plating.

Stand 84

THE PLESSEY COMPANY Ltd.,
Ilford, Essex

Precision Engine Speed Indicator (Airborne Type)†. A compact portable equipment capable of measuring shaft speeds up to 20,000 r.p.m. to the nearest 10. A standard time interval of one second is used, obtained from a low frequency N.T. cut crystal working at a frequency of 4·096 kc/s., allowing the complete division to 1 c/s. to be obtained by scale-of-two stages, i.e., 2^{12}.

The gating circuit is arranged for manual or automatic control. When used on the latter, controlled switching permits the camera operation to be synchronized with it for continuous recording.

The pick-up from the engine shaft is by means of a slotted disc and photocell. The counters are units of four scale-of-two with feedback to obtain a scale-of-ten, the indicator unit being remote from the main equipment and using miniature neons.

Breeze Components.

7 and 10 kV. Plugs and Sockets†, designed for use with Uniradio cables Nos. 39 and 21 respectively. These are completely screened coaxial pressurized units of small dimensions, the outer shell being of aluminium. Either plug or socket may be panel mounted, or the unit may be used as a cable coupler.

Mark 4 Range Concentric Plug and Socket†, designed for use with single core concentric cables Uniradio 39. The moulding retaining the pin and socket is of polythene. The maximum working voltage for the small size, unpressurized, is 2·5 kv. D.C. continuous. Insulation resistance is not less than 10^{15} ohms.

H.T. Switch for Flash Testing†. Of the rotary type, for use in insulation measuring circuits, the switch is made in various combinations up to 30-way. The principal function is that of a change-over switch operating at up to 10,000 volts.

Heavy Duty Connector†, designed primarily for connecting ground supplies to aircraft where an intermittent current rating up to 1,000 amp. is required; the nominal continuous rating is 250 amps. The fixed portion incorporates a microswitch for operating a contactor between the aircraft unit and the busbar. The ground portion is designed to accommodate a Dustart No. 2 cable.

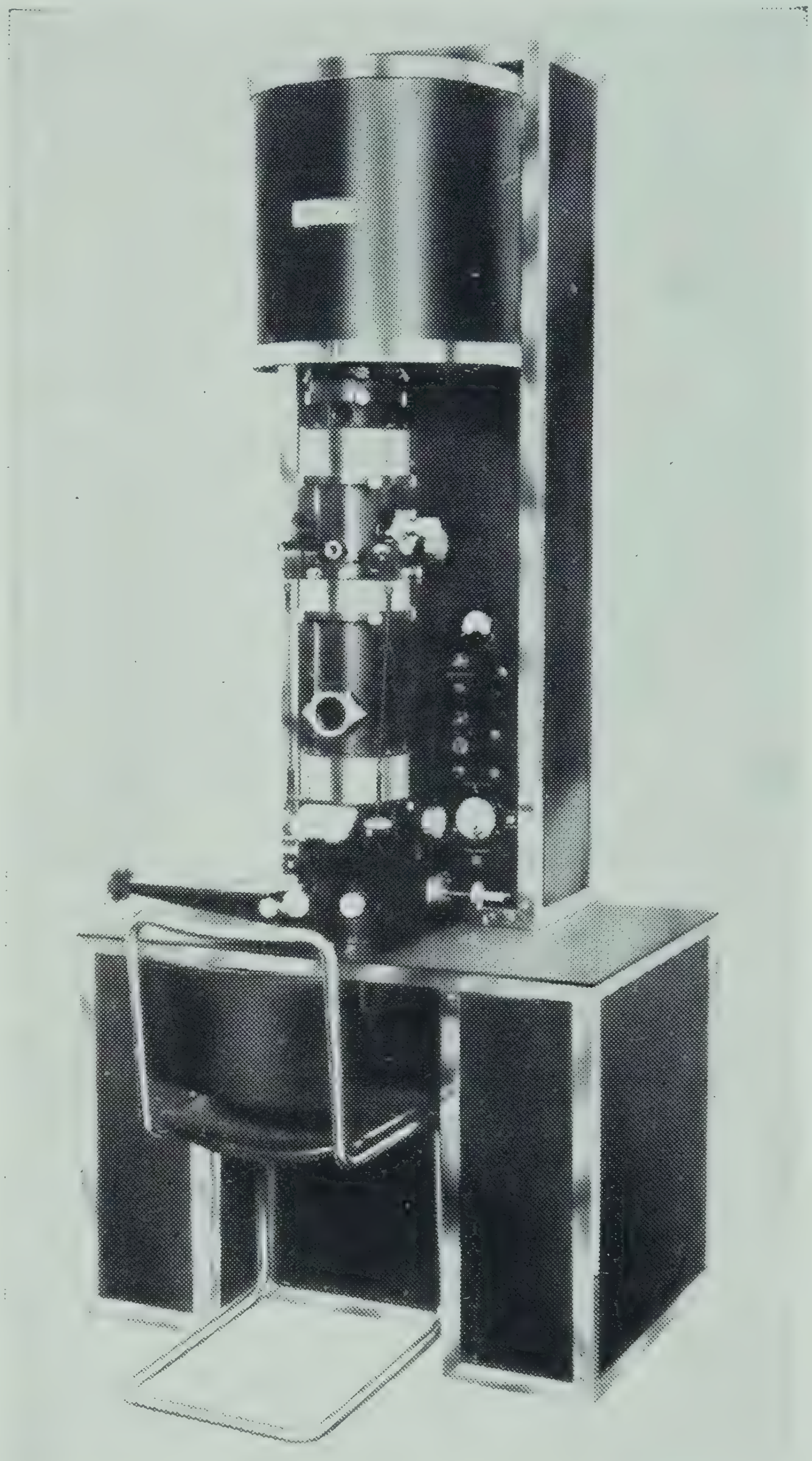
Multipin Thermocouple Connector†. This connector comprises twenty 7-amp. and four 19-amp. pins, 12 of brass and 12 constantan, and provides 12 thermocouple connections in one housing.

Wavemeter 15 - 10,000 Mc/s. Test Set 272†. Frequencies are measured by reference to a calibrated butterfly oscillator, 400 — 800 Mc/s. This oscillator is referred to a second, 15 — 30 Mc/s., and a third, 14·9 — 30 Mc/s., which can be set in terms of harmonics from a 100 kc/s., G.T. quartz crystal. The frequency difference between the second and third oscillators is determined by a fourth, 200 — 300 kc/s., and a final accuracy of 1 in 10^5 is given over a wide range of temperature.

Electron Microscope† (see Figure). This instrument is of the vertical type and operates at 50 kv., with three electromagnetic lenses covering a range of magnification from 50 to 20,000 diameters.

The objective lens may be corrected for any residual astigmatism by means of external controls, adjustable while the instrument is running, thus achieving a considerable improvement over conventional methods.

Increased contrast is obtained by the use of objective apertures of diameter as small as 10 microns, which can be centred by external controls in several seconds and may be changed in only a few minutes. The setting-up time is considerably reduced by the addition of these two features, and by the provision of air-locks on the specimen and photographic chambers which minimize the evacuation time and avoid frequent atmospheric contamination of the microscope. Methodical examination of specimens is made possible by calibration of the specimen stage.



Electron Microscope.

Electron diffraction may be carried out both by reflection and transmission. In all cases, as with microscopy, photography of one to ten patterns is available at each loading of the camera.

The special 'unit' construction of the instrument permits a choice of any, or all, of the features mentioned by selection of the appropriate units. Rapid obsolescence is avoided, the principle providing for ready modification to meet scientific advances and individual specialist requirements.

X-Ray Camera for Very High Temperatures†. A 19-cm. diameter high temperature x-ray camera with a tungsten wire furnace suitable for operation in a reducing atmosphere to a temperature in excess of 1,800°c.

The apparatus is redesigned in detail to accommodate the Very High Temperature Furnace. A fully adjustable slit system is incorporated.

Reversible Miniature A.C. Motor (Split Phase 50 c/s.)†. This motor is of the 4-pole, squirrel-cage induction type, normally fitted with a magnetic clutch, and incorporating a speed reduction gear. The operating voltage is 20-24 volts at 50 c/s. and the starting torque approximately 50 in. oz.; the running speed is approximately 54 r.p.m. under load.

E.H.T. Generator (2 - 12 kV.)†. The generator is arranged to supply a variable E.H.T. from 200 — 250 volt A.C. mains. The variable speed control is calibrated in kilovolts and gives an approximation of the E.H.T. D.C. voltage to be expected on no load at the output terminals. The regulation of this voltage is approximately 7% from 0·150 μa.

A transformer of special design using a Caslam flake iron core is used in the oscillatory circuit to provide the feedback path for the valve, a step-up for the high voltage developed and to supply power to the heaters of the rectifiers used in the voltage doubling circuit.

The speed of the oscillator, variable from 4-20 kc/s. (approximately), is controlled by bias developed across the resistance and condenser in the grid circuit.

Microwave Components†.

S.H.F. Connectors†. A range of connectors in two series — Major and Minor — having low reflection loss up to 7,000 Mc/s. and 15,000 Mc/s. respectively, for use with low-loss cables in the impedance range 70 — 80 ohms. These connectors have improvements which reduce R.F. spray.

Coaxial Wavemeter†. Coaxial centimetric type covering wavelength measurements up to 20 cm., with a vernier drive, and having an input arranged via a coaxial connector into a variable depth loop probe.

Directional Coupler†. This instrument is of the Bethe Hole type for the 6 cm. band, for circular wave guides.

Caslam†. A soft magnetic core material with a finely laminated structure for use at frequencies from 50 c/s. up to at least 10 kc/s. It has a ring permeability of the order of 1,000 and is composed of flake iron particles pressed into a compact of the desired shape in such a way as to produce innumerable thin magnetic layers aligned in the plane of the flux. Caslam blocks are supplied tested to a pre-determined specification according to the particular application, thus effecting a considerable saving in assembly cost. The A.C. losses are due almost entirely to hysteresis, the eddy current being less than 10% of the total. The A.C. permeability at 50 c/s. is, therefore, approximately equal to the D.C. figure, and at higher acoustic frequencies blocks of Caslam compare favourably in magnetic properties with built-up stacks of silicon-iron sheet.

Sealed Wire Wound Variable Resistors†. These resistors are watertight and are rated at 5 watts. The element formers of the 100 — 2,000 ohm range are of ceramic, those of the 2,000 — 50,000 ohm range of P.T.F.E.

Sealed Carbon Track Variable Resistors†. These resistors are watertight and are available with linear, log, semi-log and inverse log characteristics in values ranging from 100 ohms to 5 megohms. Hop-off resistance is 5% or 100 ohms, whichever is the smaller. The special composition brush, minimizing track wear, ensures low track noise.

Conductive Ceramics†, robust and resistant to thermal shock. These materials are mixtures of metallic oxides. By varying the composition and thermal treatment, values up to 0·1 megohm can be obtained with positive, negative and zero temperature coefficients. Miniature resistors of high wattage can be

produced as the properties of the ceramics do not alter appreciably below 400°C.

High Permittivity Ceramics†. These materials, based on barium titanate, provide dielectrics with a wide range of properties. The firing temperature may be as high as 1,500°C. The electrodes generally consist of fired-on silver paint, but platinum may be used for special purposes.

Stand 85

BALDWIN INSTRUMENT CO., Ltd., Brooklands Works, Dartford, Kent

Photometer M.N.†. This is a versatile instrument for industry and research. It can be used either for measuring the light-flux incident on one photocell or for indicating the difference between the intensities of two beams of light.

Vacuum cells are employed ensuring much higher sensitivity, stability and accuracy than is obtainable with rectifier 'barrier layer' type cells.

The Photometer unit is a simple balanced D.C. amplifier consisting of two valves in a bridge circuit. The current of a vacuum photocell is passed through the grid resistor of one valve, whilst the other compensates for variations in mains voltage and ambient temperature : high stability is thus obtained. The deflection of a microammeter is a measure of the light falling on the photocell. Three ranges are provided with relative sensitivities of 1, 10 and 100 respectively. On the most sensitive range, full scale deflection is obtained for about 100 micro-lumens. The light of a 1 candle-power source at 40 feet distance is well detectable.

The dial of the indicating instrument has an 'illumination' as well as a nearly linear 'density' scale. (Figure of Photometer overleaf).

For use as a *balance indicator* a second photocell can be connected to the instrument.

Full-scale deflection on the indicating instrument can be obtained for 100%, 10% and 1% difference between the light-fluxes falling on the two photocells.

The Transmission Densitometer Attachment serves to measure the density of photographic negatives or other transparencies. It contains a stabilized light source and is fitted with interchangeable apertures from 1 mm. to 4 mm. diameter. (See figure overleaf).

Densities from 0 to 3 are indicated with an accuracy of 0·01 ; densities up to 4·5 can be measured with a somewhat lower accuracy.

The Reflection Densitometer Attachment is a similar unit for measuring the reflection density of positive prints. With appropriate filters it can also be used for measuring colour components.

The Micro-Photometer Attachment serves to measure the transmission density of very thin lines on 35 mm. films. It can be used for evaluating spectrograms or checking the sound-track of cine-films. DEMONSTRATION.

Photo-Multiplier Photometer†. This consists of a highly stabilized, mains-operated E.H.T. powerpack. The output voltage is continuously variable from 500 to 1500 volts, at a maximum output current in excess of 3 milliamperes and is eminently suited for operating multiplier photocells, or Geiger-Müller counters.

It is shown in conjunction with a multiplier photocell. The outstanding features of this arrangement are high sensitivity and zero stability. DEMONSTRATION.

'Microphot' Photometer for Microphotography†. In photographing microscope slides it is very difficult to estimate the correct exposure time since this varies greatly with the magnification of the microscope and the camera extension as well as with the density of the specimen. The Microphot overcomes this difficulty by measuring the image brightness in the focal plane of the camera. It consists of a rectifier-type photocell in a suitable mount for placing on the viewing screen and a sensitive light-spot galvanometer. DEMONSTRATION.

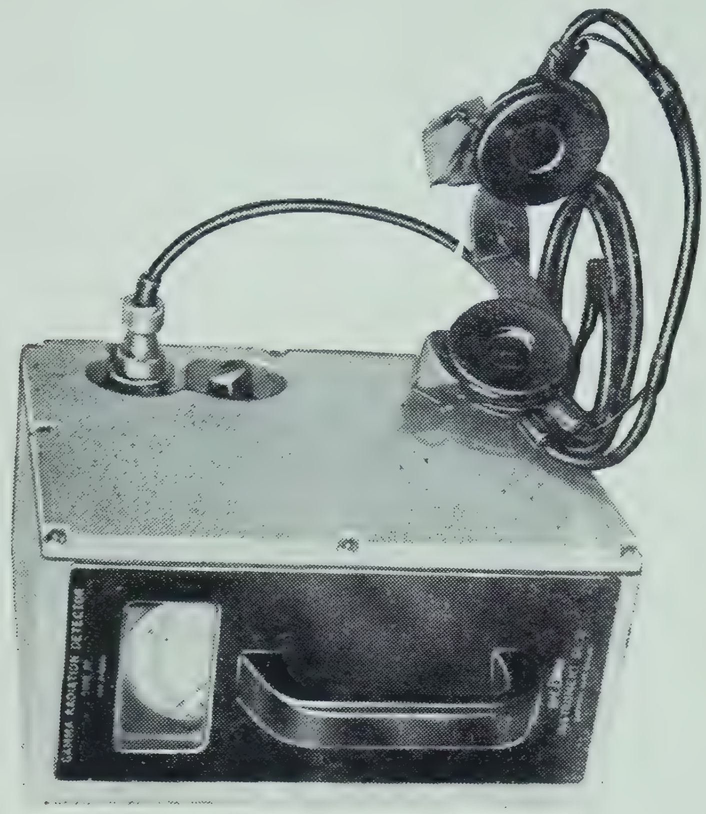
Photometer M.N.

Transmission Densitometer Attachment.

Pocket Ionization Chamber, Sealed with Diaphragm†. This is a fountain-pen type pocket ionization chamber for measuring the stray Gamma or x-radiation received by individuals exposed to such radiations, e.g., in Radiotherapy, Diagnostic or Industrial Radiography Departments and Radiation Laboratories. The chamber is hermetically sealed and desiccated to protect the insulator from moisture and dust. A diaphragm is provided for contacting the highly insulated centre electrode.

Gamma Radiation Detector, Type P.P.†. This is a compact, portable Geiger-Müller counter designed primarily for prospecting. It is also suited for finding lost Radium in hospitals and for demonstrating radioactivity in schools. A low voltage G-M tube, and cold cathode valve amplifier, are used to ensure long life of the dry batteries. An indicating instrument with approximately

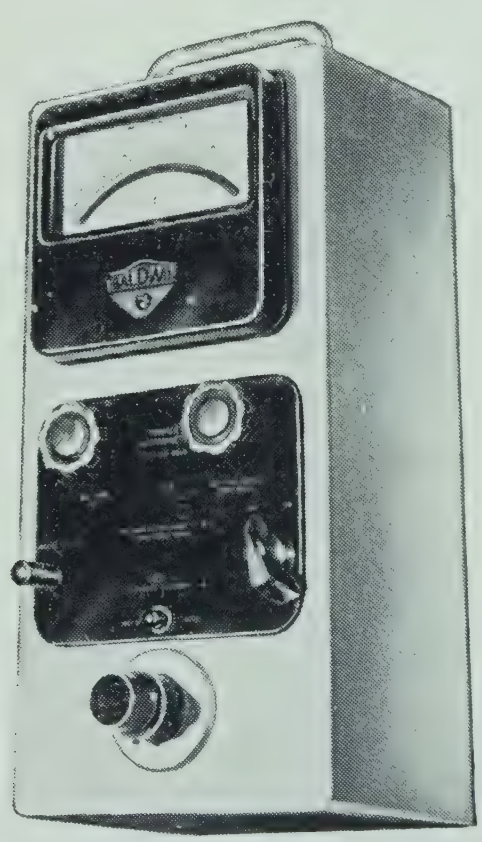
logarithmic calibration is also incorporated in the hermetically sealed case. A socket is provided for headphones to give audible signals at very low counting rate. It is fully tropical. DEMONSTRATION.



Gamma Radiation Detector.

Baldwin-Farmer Protection Electrometer†. This is a compact valve electrometer for use in conjunction with the Pocket Ionization Chamber. Any number of chambers can be used with one instrument. It serves for charging the chambers as well as for measuring the residual charge after exposure. The dose is shown on an indicating instrument which is calibrated in milliroentgens.

Dry batteries are used throughout and they have a useful life of several months even under continuous use. DEMONSTRATION.



Baldwin-Farmer Protection Electrometer.

Baldwin "Ionex" Ionization Meter†. This is a most versatile mains-operated precision ionization measuring instrument. It consists of a stable D.C. feedback amplifier with electrometer valve input stage and a wide range of inter-

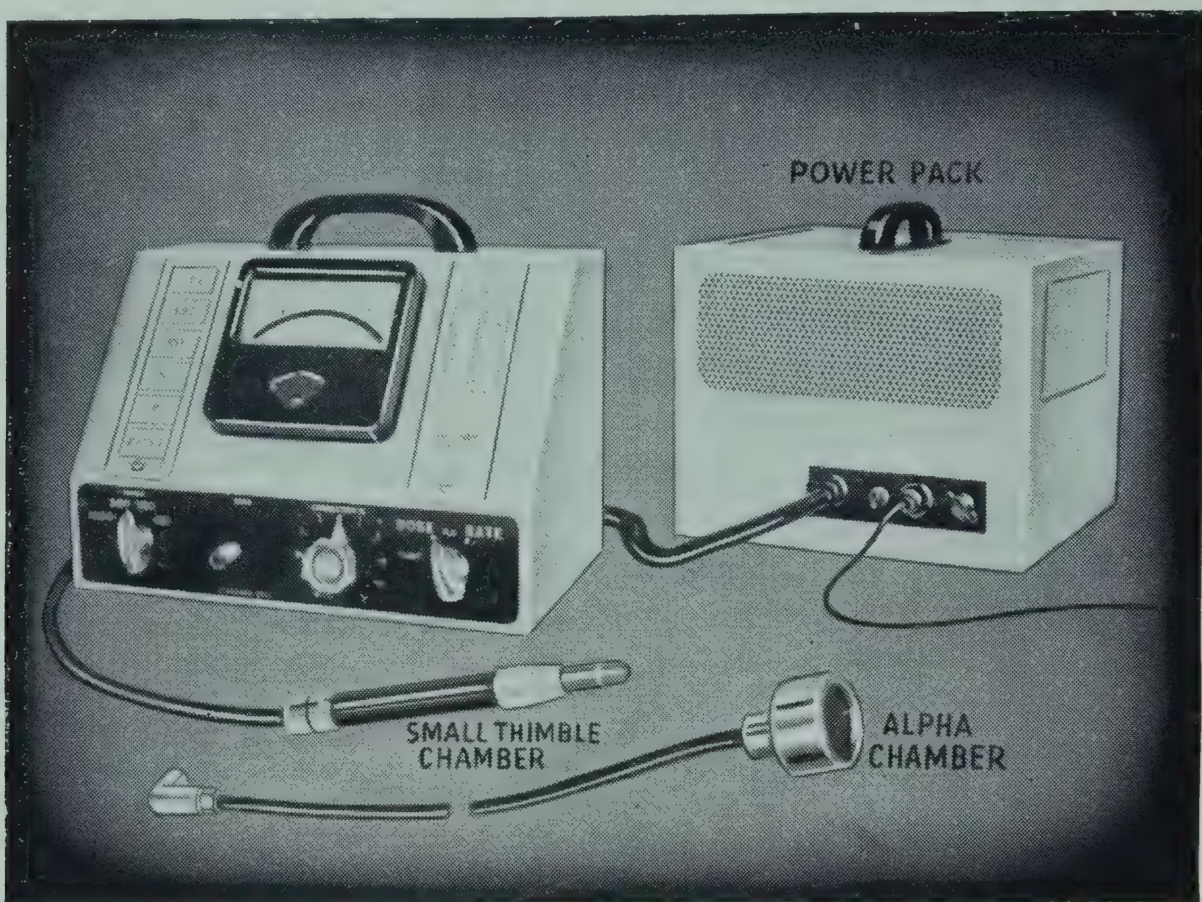
changeable ionization chambers, for alpha, beta and gamma and x rays.

A Weston cell is incorporated and facilities are provided for checking the current as well as the voltage calibrations.

The following ranges are provided: 1, 3, 10 and 30 volts, 1, 3, 10 and 30 $\times 10^{-10}$ ampere.

The accuracy is to within 1%. Zero drift is less than 1% of full scale per hour on the lowest range and proportionately smaller on the higher ranges.

Further sensitive ranges of lower stability are also incorporated giving full scale deflection for about 40, 120 and 300 millivolts, 4, 1 and 30 $\times 10^{-12}$ ampere.



Baldwin "Ionex" Ionization Meter.

With the 0·5 cm^3 standard small thimble chamber, the following radiation ranges are obtained:

dose: 30, 100, 300 and 1000 roentgens.

rate: 30, 100, 300 and 1000 roentgens per minute.

An N.P.L. calibration can be supplied with this chamber.

A larger 5-litre chamber for stray radiation provides the following ranges:

dose: 1, 3, 10, 30 and 100 milliroentgens.

rate: 1, 3, 10, 30 and 100 milliroentgens per minute. DEMONSTRATION.

X-Ray Monitor†. This low-priced instrument has been primarily designed for deep-therapy equipment to give continuous indication of tube output during treatment, but it is equally suited for superficial therapy or industrial radiography plants.

It consists of a flat ionization chamber installed in the tube head below the filter and a robust, mains-operated amplifier with a 4-inch indicating instrument.

The chamber is hermetically sealed to obviate the need for pressure–temperature corrections. DEMONSTRATION.

β-Ray Thickness Gauge†. This instrument provides a very convenient means for measuring the thickness of numerous materials — e.g., paper, plastic

sheets, metal foils. It can be used for gauging sheets as well as for continuous indication, recording or control of strips.

A radioactive isotope emitting hard β-rays is used as the source of radiation, which falls on an ionization chamber a short distance away.

If a sheet of material is placed between these the radiation will be partly absorbed and the ionization current produced in the chamber will accordingly decrease. The absorption is a measure of the mass per unit area (e.g., gm/cm^2) or thickness of the sheet.

The instrument can be used as an indicator or for driving an automatic recorder or controller. DEMONSTRATION.

Baldwin-Dunlop 'Statigun'†. This is a compact valve electrometer for the detection and quantitative measurement of electrostatic charge on stationary or moving objects. Such charge is troublesome on paper and textile machines. It is highly dangerous in an inflammable or explosive atmosphere where the charge generated for instance on a driving belt can lead to electric sparks.

The 'Statigun' serves to detect such charges and check the efficiency of any measures introduced for their elimination. When pointing the gun towards a charged surface at a fixed distance, a potential is induced on the probe electrode and this is indicated by a microammeter in the anode circuit of the miniature electrometer valve. DEMONSTRATION.

A.C. Ohmmeter†. This consists of a hand generator, the output voltage of which is stabilized over a wide range of handle speeds. Alternating current is applied to the test specimen to avoid polarization when measuring electrolytes.

A novel circuit arrangement makes it possible to provide several ranges with approximately logarithmic scale extending from 100 ohms to 10 Megohms.

DEMONSTRATION.

Stand 86

Professor R. W. DITCHBURN and Mr. H. SIXSMITH,
Physics Department, Reading University

Photoelectric Colorimeter. This instrument is intended for the determination of the concentrations of substances in solution by photoelectric measurement of the transmission of light in a region of the spectrum selected by a colour filter. There are already a number of photoelectric colorimeters in existence. The present instrument has the following special features :

(*a*) Provision is made for measuring the amount of light transmitted through any one of six cells. One of these may conveniently contain the solvent, two may be used for standard solutions and three for solutions under test.

(*b*) The preliminary adjustment of the photocell reading is made by means of a circular diaphragm which has the necessary sensitivity without backlash.

(*c*) Special care has been taken to reduce heating of the lamphouse and to prevent transference of heat from the lamphouse to the cells containing the solution.

(*d*) The essential parts are sealed to exclude dust which might affect the calibration.

(*e*) Special precautions are taken against attack by corrosive fumes or liquids.

Stand 87

Dr. P. F. HOLT,
The University, Reading

A Dust Sampling Apparatus. The mass concentration of air-borne dust is usually estimated by drawing a measured volume of air through a pad of naphthalene with a hand pump or aspirator. The naphthalene, which retains the dust, is subsequently removed by volatilization at a temperature below its melting point and the dust is weighed on the micro-balance (Briscoe, Holt, Spoor, Matthews, and Sanderson, *Med. Res. Council Spec. Rep. Series* No. 244). The exhibit is an air sampling device based on these principles. A portable electrically driven pump draws air through a napthhalene filter and expels the filtered air through a meter. By using acenaphthene to replace naphthalene, dust samples large enough for a partial chemical analysis may be collected. A new type of filter holder, in stainless steel, is fitted with standard tapered joints at either end, so that the filter will plug directly into the suction apparatus and also, when required, into a socket in an experimental dust chamber or into glass apparatus. A sublimation apparatus suitable for the removal of the filter base is also shown.

Stand 88

E.M.I. RESEARCH LABORATORIES LIMITED,
Blyth Road, Hayes, Middlesex

Scintillation Detector. In the early days of atomic research nuclear particles were detected by visual observation of the minute flashes of light produced by their impact on certain phosphors. This tedious and somewhat unreliable process has been replaced by more efficient and faster methods of which probably the latest is the photoelectric electron-multiplier adapted as a scintillation detector.

In the exhibit, use is made of the great sensitivity to light of the E.M.I. Multiplier Photo-tube, to receive the scintillations of a phosphor in intimate contact with the end window of the tube on the inner face of which is a transparent photo-cathode. Parallel to, and at increasing distances from this photo-cathode, are eleven secondary emitting electrodes, or dynodes, at each of which the incident electron current is multiplied. Under operating conditions, i.e., with steps of 160 volts between adjacent dynodes, and a total overall potential of 1,920 volts the multiplication per stage is about 4 and the overall multiplication is approximately 10^7. Thus an α-particle scintillation produces an output current capable of modulating directly an oscilloscope beam.

In the apparatus exhibited the output signal from the multiplier is fed to an amplifier and via a distribution panel to an oscillograph and also to a normal television receiver. In the former, the trace is deflection modulated by the scintillation signals, while the television receiver tube is intensity modulated by the signal, thus showing a white flash on the screen for each scintillation.

The intense α-particle signals are easily distinguished from the background 'noise', which latter is due to thermal electrons emitted from the photo-cathode. That this is so may be demonstrated, after removing the α-particle source, by the admission of a small amount of light to the photo-cathode. This merely

increases in quantity the 'background noise', but does not introduce signals of a different type. The negative character of the emission is proved by making the first dynode negative with respect to the cathode, in which case the background disappears.

The scintillation source in the exhibit is a mixture of zinc sulphide and polonium.

Stand 89

MEASURING INSTRUMENTS (PULLIN) Ltd.,

Electrin Works, Winchester Street, Acton, London, W. 3

Portable Dynamometer A.C. Test Set, Type PD. 440† (Figure 1). The movement is of the iron free dynamometer type and functions as a precision dynamometer Ammeter, Voltmeter and Wattmeter. There are five ranges of volts A.C. and D.C., from 25 up to 500 volts inclusive, five ranges of current from 0·5 up to 25 amp. A.C., and thirty ranges of watts from 12·5 up to 12,500 watts A.C., 50 c/s. Accuracy on voltage and current ranges is to within 0·5 per cent, and on power ranges to within 1 per cent. Careful shielding of the movement ensures that the accuracy of the instrument remains unaffected by extraneous magnetic fields. The instrument is housed in a hardwood case with carrying handle and removable lid.

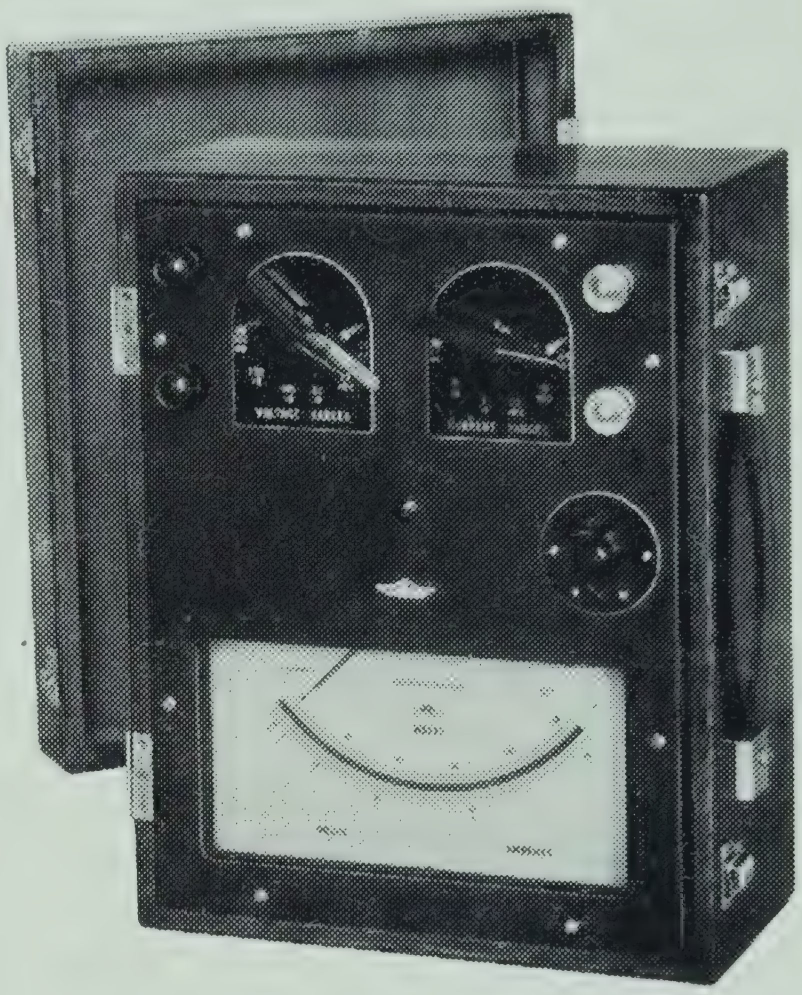


Figure 1.

Pullin Series 30 Rectangular Moving-Coil Indicators† (Figure 2). A new miniature series, designed to meet the need for a compact styled meter to harmonize with the modern trend in miniaturization, is available in all standard ranges; special damping and transit time can be arranged to suit individual requirements. The highest sensitivity is 10 microamps with a terminal resistance of 2,200 ohms.

Portable Sub-Standard Dynamometer Wattmeters. These are of the iron-free pattern and comply in all respects with B.S.S. 89 for sub-standard instruments. They will be shown fitted in reinforced Bakelite cases of special design and are suitable for tropical use.

Pullin Reflecting Galvanometer, Type GR. 127† (Figure 3). This is a sensitive moving-coil reflecting Galvanometer with self-contained optical system. It is specially designed for arduous conditions in Technical Colleges and Industrial Laboratories. Scale length : 127 mm. Angular deflection of spot : 70°.

Sensitivity : 25·4 mm/μa. Terminal resistance : 1,800 ohms. Other ranges and sensitivities are available.

Photoelectric Exposure Meter† (Figure 4). The Pullin Photoelectric Exposure Meter has been designed in collaboration with the Pullin Optical Co. who are marketing this instrument. The movement is of a special design giving maximum sensitivity and quick action. The weight has been reduced to a minimum. The magnetic system is fully protected against stray magnetic fields.

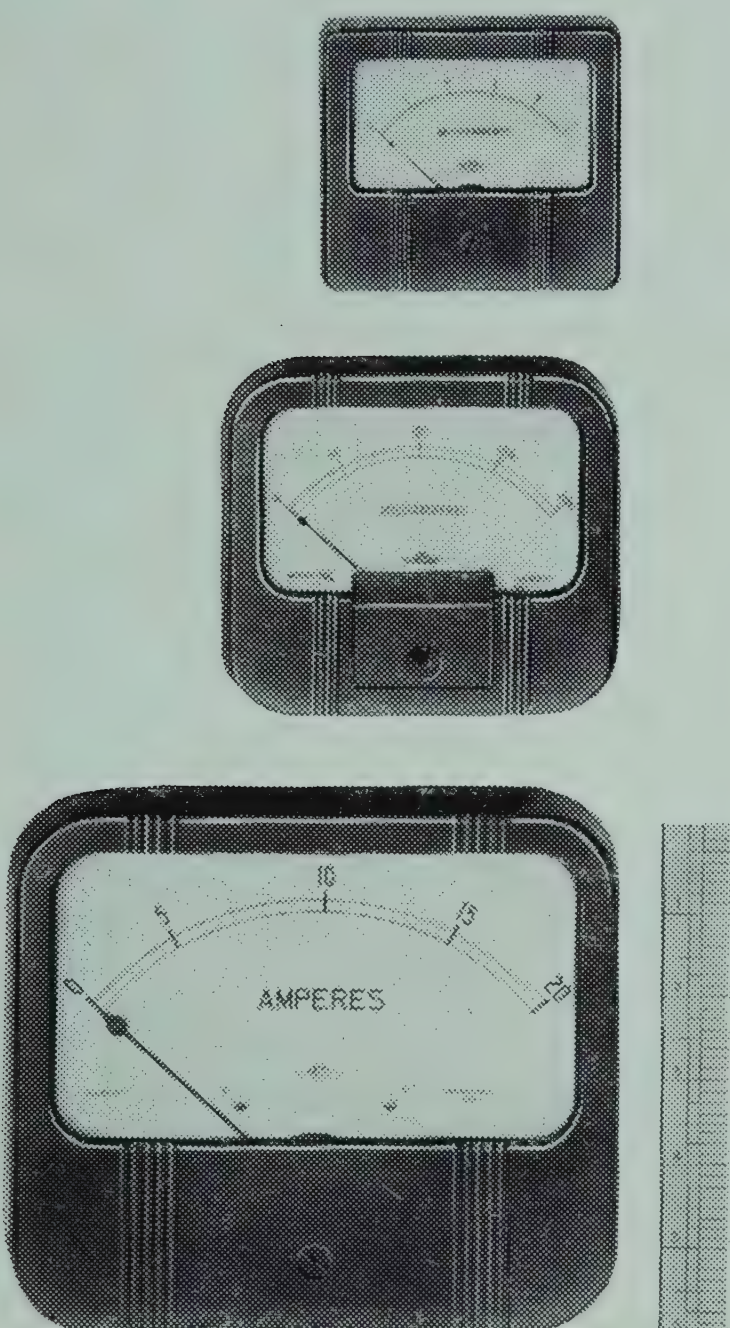


Figure 2.

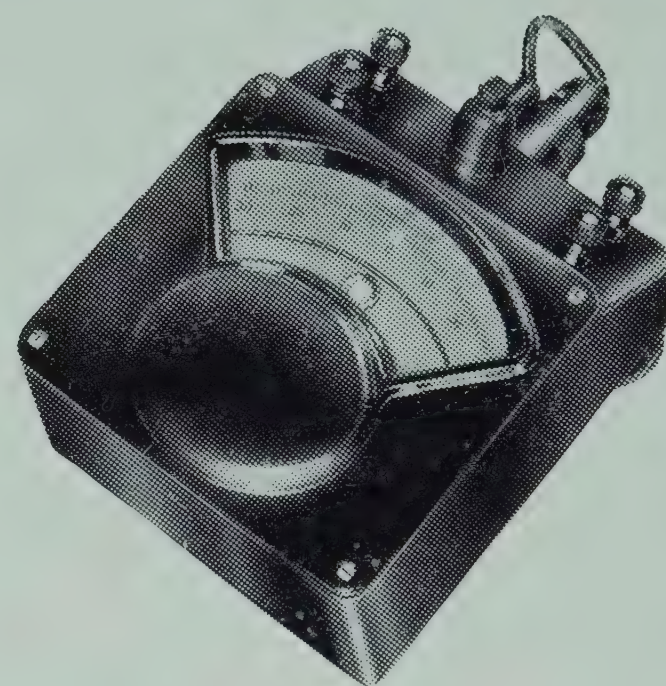


Figure 3.

Figure 4.

A light weight index pointer is fitted, thus ensuring minimum overswing should the instrument be suddenly jolted while a reading is being taken. The photo-electric cell is hermetically sealed and fitted with directional grill and lens. The Acceptance Angles are : Horizontal 65°, Vertical 75°. Ranges are provided by means of a press button on the side of the case.

Low Light Range : 1 – 24 foot-candles ; High Light Range : 25 – 6,500 foot-candles.

A conversion table is provided to give the foot-candles at various points on the scale, so that the instrument can be used as a light meter. The instrument is housed in a metal die-cast case of unusual design and shaped so that it fits easily into the hand or the vest pocket. A special wrist fitting is provided so that it can be worn like a watch. Provision has been made in the magnetic system to

prevent any damage to a wrist watch worn at the same time. The usual lanyard is supplied and the total weight is only 4 oz. The exposure dials of the meter cover f/stops from f/1.4 to f/45 and shutter speeds from 1/1000 sec. to 2 minutes. The Emulsion speed scale uses the B.S. Index and D.I.N. Overall dimensions are : $2\frac{3}{4}$ in. × $1\frac{3}{4}$ in. × 1 in.

Other Exhibits include the Suspension Pointer Type Galvanometer, Frequency Meters and Moving-coil and Moving-iron Industrial Pattern Instruments of modern design and construction.

Stand 90

DE HAVILLAND PROPELLERS Ltd.,
Hatfield, Hertfordshire

Equipment for Fatigue Testing

1,000 Watt Mains Driven Moving Coil Vibrator Type 1/D1† with rectifier for field magnet polarizing supply, designed for the electromagnetic excitation of vibrations from zero to 1,000 c/s. in large and complex structures such as aircraft, automobiles and small civil engineering structures.

The coil former of the moving-coil assembly has a skirt and header of non-magnetic alloy and is supported at each end of the vibrator on cloth-bonded synthetic-resin spiders which provide great flexibility in the axis of excitation only. The construction allows a maximum movement of the coil of 0·25 in. in either direction from the ‘ at-rest ’ position.

The natural frequency of the unloaded moving-coil assembly, which weighs 4 lb., is a function of the flexibility of the supporting spiders and is of the order of 5 c/s. The coil will pull 30 lb/amp. of excitation current, so that at full load an alternating thrust of about 250 lb. can be obtained up to a frequency of 1000 c/s.

The model shown is driving a fatigue test specimen in conjunction with other apparatus exhibited. DEMONSTRATION.

40 Watt Power Amplifier Type 3/A1† driving the moving-coil vibrator described above. The output stage of this amplifier consists of two valves in Class AB 1 push-pull which are driven from a pair of triodes in a floating paraphase phase splitter. Pentode and direct-coupled triode amplifiers precede the phase splitter. The secondary winding of the transformer is tapped to give a range of output impedances from 2 to 30 ohms. Negative voltage feedback is applied from a tertiary winding on the output transformer to the cathode of the input valve, ensuring a flat response over the range 10 to 4,000 c/s. Anode current meters are provided for the output valves. The input arrangement consists of a double-pole and earth jack and high impedance input potentiometer.

DEMONSTRATION.

Self-Driving Unit Type 31/A1† (Figure 1). Fatigue test specimens excited with an electromagnetic exciter, as described above, may be conveniently run at their natural frequency by means of a regenerative circuit. This is effected by driving the power amplifier from a vibration pick-up situated on the vibrating speci-

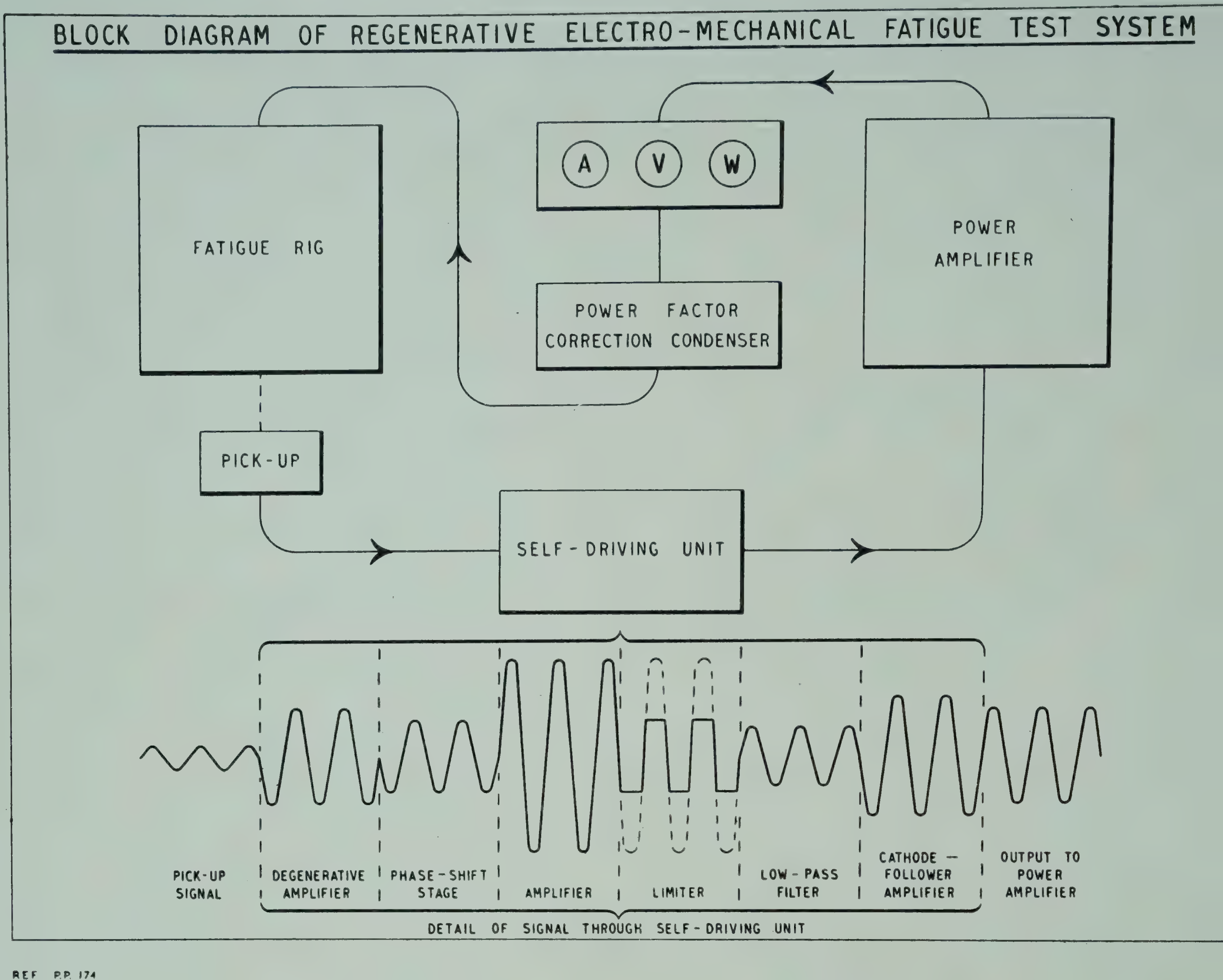


Figure 1.

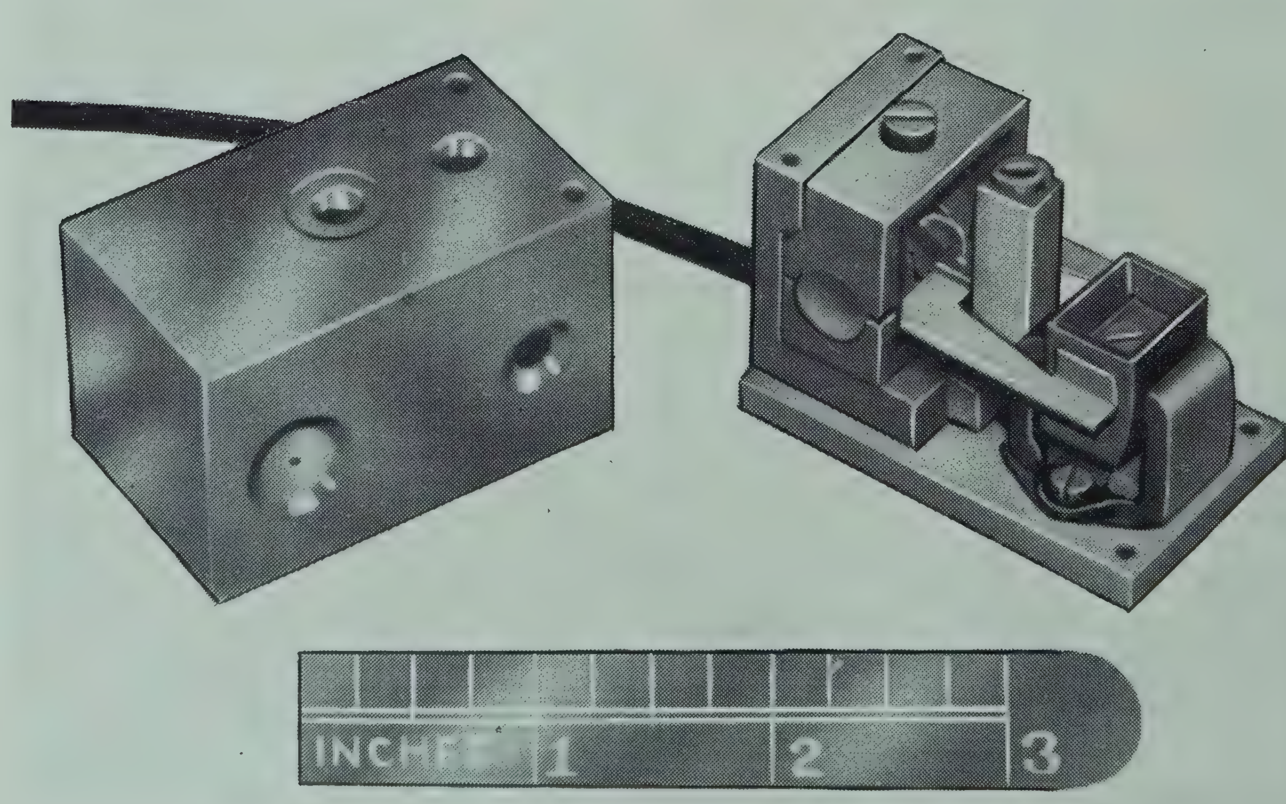


Figure 2.

men with suitable phase shift of the pick-up signal. This input limiting unit provides the phase shift adjustment over the range of $\pm$ 180° and in addition a chopper device gives a fixed but adjustable input signal to the power amplifier, irrespective of random variations in the pick-up signal. Thus the fatigue specimen may be run at a fixed amplitude (stress) level. Filters over the range 10 to 1,000 c/s. are also incorporated to extract the fundamental pick-up frequency.

DEMONSTRATION.

Miniature Moving-Coil Vibration Coil Pick-Up Type 9/B1† (Figure 2) for the detection and measurement of linear vibration amplitudes and velocities in members large in mass compared with itself.

This instrument responds to a single component of vibration and is designed for use in either the vertical or the horizontal axis. It has a natural frequency of the order of 9 c/s. and is particularly suitable for the measurement of engine vibrations. The instrument is exhibited as the feedback source for the input limiting device described above. DEMONSTRATION.

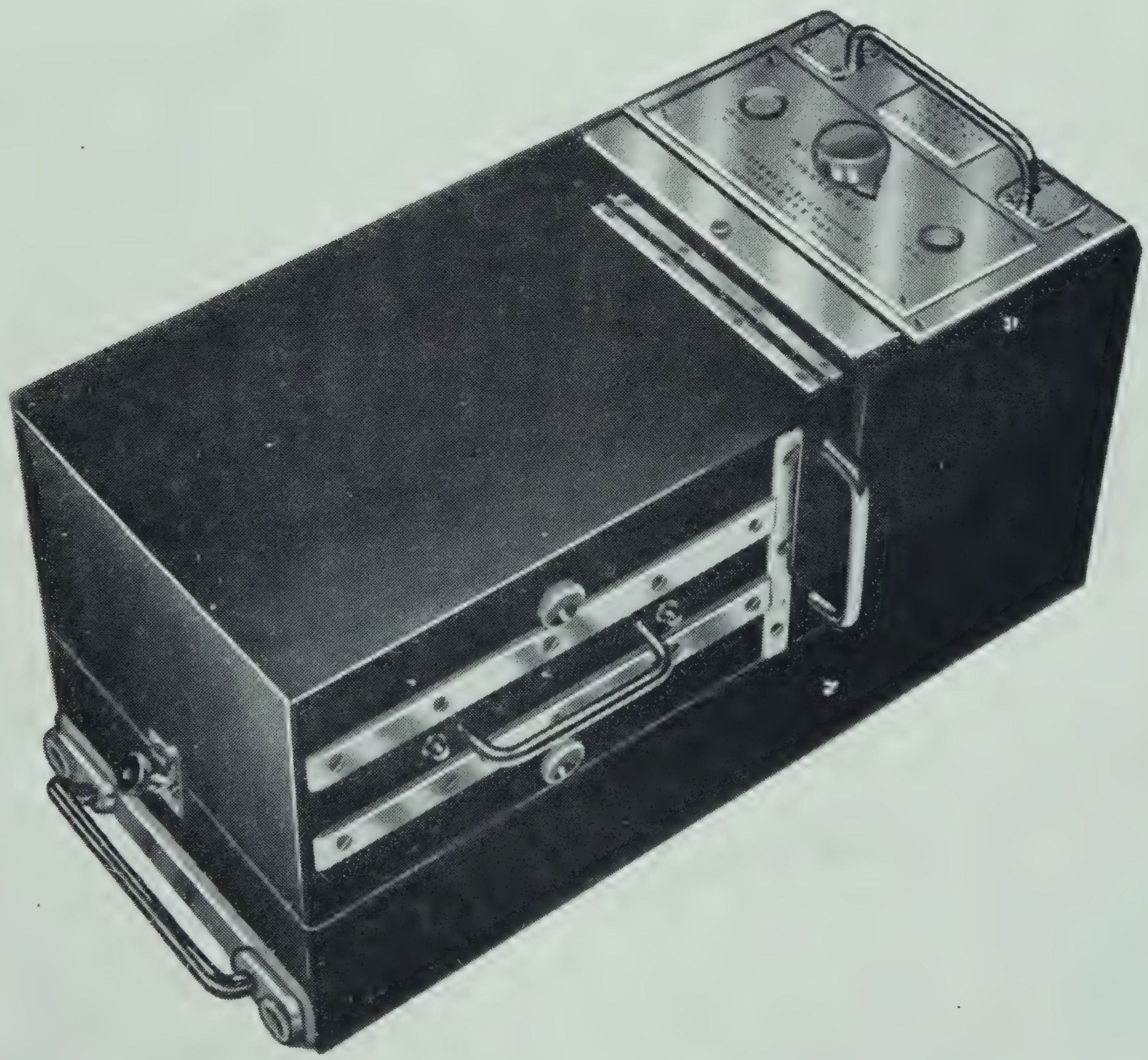


Figure 3.

Oscillograph Recording Camera Type 6/B12† (Figure 3) of the galvanometer steadily-moving film type, capable of photographing up to twelve oscillatory or transient input signals simultaneously. A time base is provided by a flashing

discharge lamp and a second lamp is incorporated which may be suitably triggered to give recordings of r.p.m. or other timing of phenomena on the equipment undergoing test. The frequency response is substantially flat up to 800 c/s. with very high sensitivity ; full trace of $\frac{3}{4}$ in. is given by an A.C. signal of 0·3 volt peak.

The magazine, which is removable, carries 130-ft. rolls of 6 in. recording paper and is driven from a multi-speed gear-box. A control giving various predetermined times of recording is incorporated, together with control leads to a film-footage indicator situated on the associated amplifier equipment. An automatic record-numbering device is also included. The main framework, cast in a light alloy, contains four quickly detachable panels giving ready access to the whole of the interior. Care has been taken to reduce to a minimum the number of projecting parts, a feature of value when working in confined spaces. The dimensions are such as to allow mounting in a standard R.A.F. type radio rack, if so desired.

Twelve-Channel Equation Computer. An analogue computer to solve twelve similar linear equations of the general form :

$$a_1 x_1 + b_1 x_2 + c_1 x_3 + d_1 x_4 + e_1 x_5 + f_1 x_6 + g_1 x_7 + h_1 x_8 + i_1 x_9 + j_1 x_{10} + k_1 x_{11} + l_1 x_{12} = m_1 \quad (1)$$

$$a_2 x_1 \cdots\cdots = m_2 \quad (2)$$

$$a_3 x_1 \cdots\cdots = m_3 \quad (3)$$

$$\cdots\cdots$$

$$a_{12} x_1 + b_{12} x_2 + c_{12} x_3 + d_{12} x_4 + e_{12} x_5 + f_{12} x_6 + g_{12} x_7 + h_{12} x_8 + i_{12} x_9 + j_{12} x_{10} + k_{12} x_{11} + l_{12} x_{12} = m_{12} \quad (12)$$

The usual iterative method of solution is normally employed but provision is also made for finding the latent roots λ of a determinant. The apparatus consists of a central panel and two wing panels. The left and right-hand wing panels contain respectively the coefficients of equations (1) to (6) and (7) to (12). The central panel contains all the common apparatus and the values of x and m.

The coefficients and values are all set on potentiometers (standard 10kΩ 15 watt linear wirewound potentiometers are used) which are each provided with a two-way sign (+ or –) switch and a setting jack. This jack enables the magnitude (but not the sign) of each component to be compared with a built-in common 3-dial Decade Sub-standard Potentiometer.

In the method for determining the latent root of a determinant (λ method) provision is made for the semi-automatic transfer of the m of one trial to the x of the next, multiplied by 1/5, 1 or 5 as necessary.

The computer is energized from a 50 c/s. supply (derived from the supply mains) and a 'Magic Eye' Tuning Indicator is used as a null detector. The apparatus is semi-automatic, equation selection and switching functions being performed by Uniselectors and relays. All the supplies are obtained from the supply mains. DEMONSTRATION.

Stand 91

THE ROYAL TECHNICAL COLLEGE, GLASGOW

Electrical Engineering Department

Mr. J. Brown, Mr. C. Hammond, and Professor F. M. Bruce

The apparatus displayed was designed and constructed in the Workshop of the above Department.

High-Tension Voltmeter. As shown, this instrument is made for recording voltages up to 100 kv. r.m.s., but the scale can be calibrated for peak voltages, and sensitivity controls enable full scale deflection to be obtained for any chosen voltage. The calibration is linear. The controls and indication are remote from the high voltage connection, and may therefore be mounted at any convenient control point.

A stub aerial connected to the grid of a triode valve assumes the potential of the point at which it is placed in an electrostatic field. For a given position, this voltage will vary with the total voltage establishing the field, and the variation in anode current can be calibrated in terms of kilovolts. The change in anode current is recorded on a rectifier instrument fed through a coupling transformer. Sensitivity control may be obtained by varying the anode resistance or the leakage resistance from aerial to earth, and the range is determined by the initial biasing voltage and the exposure of the aerial above a guard ring.

The aerial is exposed at a point in the field between two curved electrodes, and the calibration is thereby made independent of the proximity of surrounding objects. The voltmeter can be adjusted to give an indication in the vicinity of 250 volt supply mains, and in miniature form it can be used as a ‘ live-main ’ detector.

Drum Camera. The camera was developed as a portable means of recording relatively low-speed phenomena, and all electrical supplies are taken from accumulators.

The revolving drum, 10 in. in diameter, carries paper or film 35 mm. or 70 mm. wide, and is mounted in a cassette which can be removed for loading without disturbing the rest of the apparatus. The cassette has two rack-operated shutters which can be opened when recording to admit light from the event to be recorded and from a timing spark.

A 1/25 H.P., 24 volt D.C. shunt motor fitted with a potentiometer speed control drives the drum through a two-speed reduction gear-box, giving drum speeds of 0–2 and 0–10 revolutions per second, equivalent to resolutions of 0–63 and 0–315 inches per second on the records. The speed is indicated on a meter in the motor circuit, and the use of relatively high motor speeds with accumulator supply eliminates measurable variations in drum speed.

The camera casing is slotted transversely to the drum surface, the slot width being variable from 0–1 in. by a parallelogram movement which maintains the centre line of the slot in a fixed position. A quarter-plate double-extension camera, with rising and cross movements on the lens holder, is mounted over the adjustable slot. Various lenses, apertures, and exposure times are obtainable from the controls on this camera.

Timing dots at 0·02 second intervals are obtained from an electrically main-

tained tuning-fork and spark coil, the spark gap itself being mounted close to the film surface and focused through a pin-hole. This unit may be traversed to record at any position on the width of the film.

Momentary pressure on one cable release records the timing trace for one revolution of the drum, and also opens the camera shutter for a time just less than that for one revolution, leaving an unexposed length of some 3 in. which is available for ‘ still ’ calibration records.

The camera has a variety of applications, including the recording of traces from one or more oscillographs, and the recording of mechanical movements by light from a flashlamp bulb or spherical reflector attached to the moving part. Successive records can be given a relative displacement across the width of the film by traversing the camera lens and timing spark between exposures. Typical records will be shown.

Klydonograph. The model shown was designed for use by students on minor investigations, and has a range extending to about 14 kv. peak. Recording is carried out on quarter-plate glass negatives, or on continuous film or paper 70 mm. wide carried in cassettes holding 25 ft. rolls, which can be interchanged in daylight.

Sheet insulation of various thicknesses can be mounted between the recording medium and the plate forming the earthed electrode. The high voltage electrode may be any one of a number of the shapes provided, e.g., pointed, cylindrical, spherical, all of which are interchangeable. These are screwed to the end of a vertical rod forming the high voltage terminal, a jointed coupling being used in the case of the cylinders so that the flat end surface can accommodate itself to the plane of the photographic plate. The rod can be clamped in a raised position whilst the film is being wound forward. A graduated film indicator is provided, and also a probe which punches the film itself to provide identification of the different frames during processing.

Stand 92

UNIVERSITY COLLEGE, SOUTHAMPTON,
Departments of Electronics and Physics

Mr. S. W. Punnett and Mr. H. G. Jerrard.

Electronic Tachometer. An instrument capable of measuring the speed of revolution of a shaft to an accuracy within 0.05%.

The rotation of the shaft is made to generate an alternating voltage which is fed through an R-C coupled amplifier to the Y plates of a cathode-ray tube. The output of a variable frequency oscillator is connected to the X plates. The resulting pattern on the tube is a Lissajous figure. A calibration unit accurate to 0·05%, which consists of a crystal controlled standard frequency generator coupled to a selective amplifier, can be connected to the Y plates instead of the A.C. amplifier output, so that periodic checking of the oscillator can be carried out.

Two methods are shown by which the initial alternating voltage may be produced. In the first method light is reflected at regular intervals from the shaft on to a photocell ; in the second method, a disc having small iron pegs equally spaced along its circumference is attached to the shaft and each pin in turn passes through a magnetic field whereby a voltage is induced in a small pick-up coil.

In both cases the oscillator frequency is adjusted so that an elliptical pattern appears ; the shaft speed in revolutions per minute is simply this frequency multiplied by a simple integer.

The instrument, in addition to its high accuracy, is suitable for shafts of any size, imposes no load, indicates immediately any change in speed, covers all possible speed ranges and unlike the stroboscope is unambiguous. Furthermore it enables a shaft to be adjusted accurately to any predetermined speed. DEMONSTRATION.

Stand 93

CAVENDISH LABORATORY,
University of Cambridge

Mr. G. G. Scarrott.

New Electronic Decade Scaler. The essential part of the scaler is a ring circuit of five triodes in which each grid is coupled by a pair of resistances to the anodes of both neighbouring valves in the ring. The cathodes of the ring are driven by a cathode follower from a square waveform derived from an ordinary scale of two. There are then two possible states of the ring corresponding to the two possible states of the scale of two. They are :

'A' state : cathodes of the ring at high potential — 2 valves in the ring conducting, 3 valves in the ring cut off.

'B' state : cathodes of the ring at low potential — 3 valves in the ring conducting, 2 valves in the ring cut off.

There are five possible 'A' states and five possible 'B' states, i.e., ten in all. The anode grid coupling resistances from left to right are made of a higher value than those from right to left. When fed with pulses to the scale of two, the ring circuit goes through its ten possible states systematically. The order of counting is : A_1, B_1, A_2, B_2, A_3, B_3, etc.

The scaler shown is equipped with three scales of ten. The first is made with high currents in the valves to reduce the resolving time to 5 microseconds. The other two rings are made with high resistances and small currents to reduce the power dissipation and so gain in stability and long life.

Stand 94

ERNEST TURNER ELECTRICAL INSTRUMENTS Ltd.,
Chiltern Works, Totteridge Avenue, High Wycombe, Bucks.

Sealed Instruments†. These instruments now appear as production articles, ranging from 2 in. to $3\frac{1}{2}$ in. The complete sealing over a great range of temperature is achieved independent of glass thickness. Double magnetic screening renders the instrument calibration free from the usual variation due to ferrous or non-ferrous panels. The sealed zero adjuster is a special feature since it operates satisfactorily at both high and low pressures and is independent of temperature.

Long Scale Instruments†. The new design of this type of instrument makes for extremely robust layout, has an angular deflection of 240° and gives an extremely

good performance under vibration. Recent tests show that when subjected to frequencies of between 10 and 150 cycles per second the maximum pointer creep over this range of frequency does not exceed $\frac{1}{2}\%$ of full scale deflection.

Sub-Standard Moving Coil Instruments†. The high order of materials and workmanship used on this type provides a robust and easily read instrument hitherto not easily obtained. The instrument is rigidly mounted on a generous sub panel and fitted with a completely removable teak cover which when clipped into position on the base gives adequate protection and an easy method of transportation. Main features are scale length, 8 in., accuracy to within 0·2% of indication, clear and distinct scaling, rather more than average resistance to shock.

Rectangular Types†. These are available in moving-coil, moving-iron and electrostatic types: high torque ratio and easy readability are special features. These instruments are extremely pleasing in appearance and are becoming very popular on modern panel layouts. Types cover 2 in. × 2 in., 2½ in. × 2½ in., 4½ in. × 4½ in. and 6 in. × 5 in.

Suspended Mirror Galvanometers†. Panel mounting, single and multi channel types are shown. Compact design has made for high sensitivity coupled with comparatively small space factor. Sensitivities down to one microampere per meter with a coil resistance of 800 ohms are demonstrated. In particular the multi channel type has a high natural period coupled with good sensitivity so rendering satisfactory operation under conditions of vibration. This model is available in 3, 6, 8 and 12 elements. The panel mounting type presents the same frontal appearance as the rectangular 6 in. × 5 in. instrument and has a self-contained lamp and optical system. DEMONSTRATION.

Milliamp Second†. Two types are shown, one in the 4 in. × 4 in. case and the second in the 6 in. × 5 in. case. The redesign has made for an extremely light and compact unit. These types are smaller and neater than the general conception of this instrument. Full scale deflections range from 1 milliampere second upwards.

Pen Recorder†. This instrument has been designed in collaboration with Messrs. Taylor, Taylor & Hobson of Leicester to meet a specification for a compact inkless recorder having a linear response up to 30 c/s., rectilinear ordinates and a sensitivity of 7 milliamperes per inch deflection, coil resistance 7,500 ohms and a maximum amplitude of some 6 centimetres.

In addition to the above it is hoped to show examples of the American standard V.U. meter, frequency meter, hour counting meter and double programme indicator.

High Power Stroboscope Model SS20† provides a very high light intensity for stroboscopic applications and is particularly suitable for the examination of rotating or reciprocating mechanisms in the presence of normal illumination or under conditions of bad visibility. A special Xenon filled quartz discharge tube with sealed-in reflector is contained in a light moulded unit which can conveniently be held in the hand or mounted in any suitable position; this unit also includes provision for the remote control of the power unit to which it is connected by means of a flexible lead.

The equipment can be operated over the range of 200 — 3,000 flashes per minute with an energy dissipation of 500 watts for a limited duration or at a reduced intensity for long periods. The flash rate can be controlled by an oscillator, by mechanical contacts, or by electrical impulses, and provision is included for single flash operation. The equipment is A.C. mains operated, and full protection by automatic safety devices is provided.

Stand 95

TAYLOR ELECTRICAL INSTRUMENTS Ltd.,
419/424, Montrose Avenue, Slough, Bucks.

Universal Test Meter, Model 70A†. This robustly constructed general purpose instrument has a 4 in. scale length and a total of 50 ranges covering A.C., D.C. and resistance measurements, with a sensitivity of 1,000 ohms per volt on A.C. and D.C. volt ranges. Meter overload protection and a buzzer continuity test are included.

Universal Test Meter, Model 75A†. Fifty ranges are provided by this instrument, which covers A.C. and D.C. volts up to 5,000 A.C. and D.C. current from 50 μa. to 5 amp., and resistance from 1 to 10 megohms. The sensitivity on A.C. and D.C. voltage ranges is 20,000 ohms per volt.

Universal Test Meter, Model 85A† (Figure 1). A total of 90 ranges includes D.C. voltage ranges from 0·05–5,000, D.C. and A.C. current from 50μa. to 10 amp., A.C. volts from 1 to 5,000 and resistance from 0·1 to 20 megohms. The sensitivity on A.C. and D.C. voltage ranges is 20,000 ohms per volt.

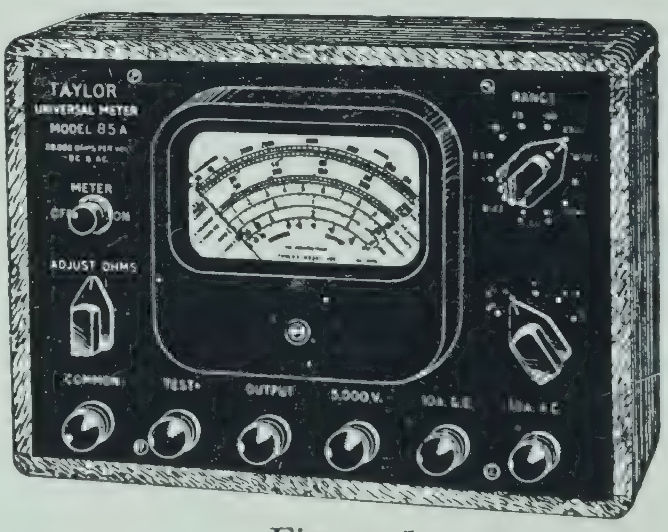


Figure 1.

Univeral Test Meter, Model 120A†. Twenty-one ranges covering D.C. voltage and current A.C. voltage, and resistance measurements are provided by this pocket size instrument which is housed in a shock-resisting moulded case. The sensitivity is 1,000 ohms per volt on A.C. and D.C.

Universal Test Meter, Model 125A† (Figure 2). This instrument is similar in construction and appearance to Model 120A. Seventeen ranges are provided, covering D.C. voltage and current, A.C. voltage, and resistance measurements. It is particularly useful in industrial testing.

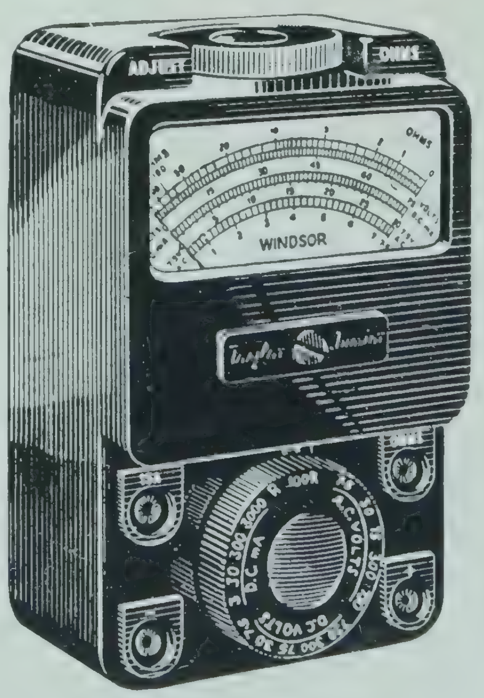


Figure 2.

Universal Test Meter, Model 90A†. This forty-range meter has a sensitivity of 1,000 ohms per volt on D.C. and A.C., and its accuracy on all ranges conforms to British First-grade Specification. It is fitted with overload-protection.

Insulation and Circuit Tester, Model 130A†. A mains-operated ohmmeter with two ranges measuring from 20 ohms to 100,000 ohms and from 0·2 to 1,000 megohms respectively, with centre scale readings of 800 ohms and 8 megohms. A test voltage up to 500 is applied on the higher range.

Megohmmeter, Model 290A†. This A.C. mains-driven ohmmeter incorporates a valve voltmeter and gives direct readings of resistance from 20,000 megohms in four overlapping ranges.

Resistance and Capacitance Bridge, Model 110B† (Figure 3). This A.C. bridge has seven capacity ranges to enable measurements to be made from 10 pF. to 1,200 mF., and seven resistance ranges are available covering 0·1 ohms—12 megohms. Power factor measurements up to 50% are available on all capacity ranges.

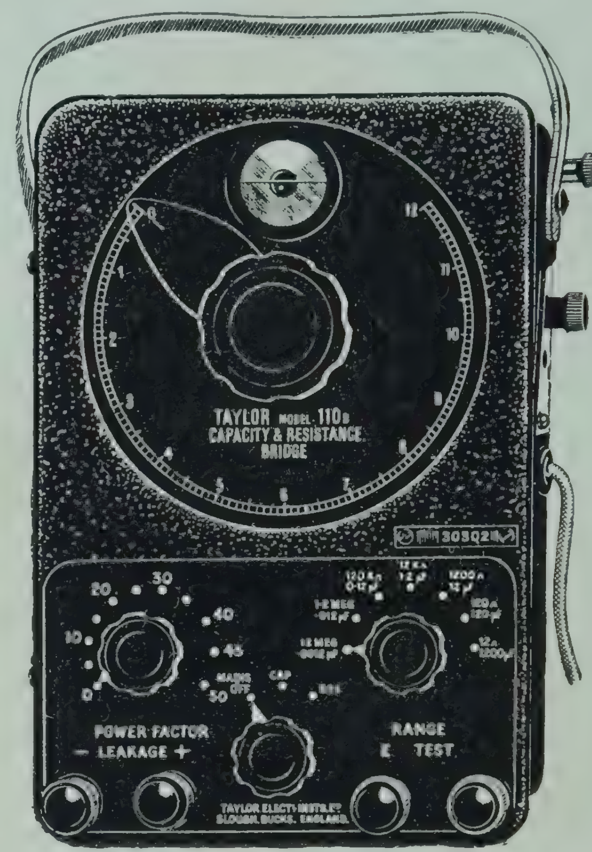
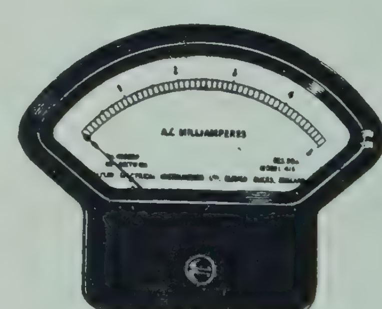


Figure 3.

Valve Tester and Universal Meter, Model 47A/S†. This measures the mutual conductance of amplifying valves by measuring the ratio of change in anode current with change in grid volts. Two ranges are available, 0–3 and 0–15 ma/v., the lowest reading being 0·1. Diodes and rectifiers are checked for emission under normal working conditions. Each section of frequency changers and other multiple valves can be tested separately for either mutual conductance or emission ; an extra panel at the bottom of the instrument enables the meter to be used for measurements of A.C. and D.C. voltage, D.C. current and resistance.

Ohmmeters, Models 4 and 5†. These ohmmeters incorporate the Taylor 4 in. or 5 in. scale moving-coil instrument, mounted in a metal case with sloping front panel. Single or multi-range instruments are available, each range covering three decades.

Switchboard and Miniature Instruments† (Figure 4). Several improvements have been made in the design of the complete range of moving-coil and moving-iron instruments shown. Features of the moving-coil instruments are robust movements with high torque to weight ratio, excellent overload characteristics, and improved die-cast movement frames. A complete range of microammeters, milliammeters and ammeters are manufactured as well as thermocouple and rectifier types. A new moving-iron movement is also shown which incorporates a die-cast movement frame and high permeability fixed and moving elements.



MODEL 415

Figure 4.

Scales range from 2 in. to 5 in. and a new 4 in. scale sector shape moulded case is shown.

Type 970 Switch†. A range of wafer type instrument switches with heavily silvered brushes and contacts are shown. Various combinations of decks and poles together with heavy duty ratings up to 10 amp. can be made.

Stand 96

EVERSHED & VIGNOLES Ltd.,

Acton Lane Works, Chiswick, London, W.4

'Megger' Insulation Tester, Series 1†. The instruments in this series comprise the latest long scale, high range testers having ranges up to :

500 volts	..	..	10,000 megohms,
1,000 volts	..	..	20,000 megohms,
2,500 volts	..	..	50,000 megohms.

'Megger' Insulation Tester, Series 4† (for illustration see our advertisement). A new instrument in a black plastic case with spring terminals, a constant pressure 500 volt generator and an ohmmeter with a range of 0–50 megohms. It can be provided with a range switch to divide the readings by 100, or an additional continuity range scaled 0–100 ohms.

'Megger' Earth Tester, Series 4†. This instrument is similar in appearance to the Series 4 Insulation Tester, but has two pairs of spring terminals and two switches arranged to short circuit each pair at will, enabling the tester to be used as a 2, 3 or 4 terminal instrument to suit the requirements of any particular test. It operates on the same principle as previous 'Megger' Earth Testers, but has an A.C. generator instead of a D.C. generator and current reversers. Each instrument has two ranges and the two patterns available have ranges 0–40 and 0–200 ohms, and 0–100 and 0–500 ohms.

'Megger' Earthometer Tester, Series 4†. (Patent No. 456,766). This instrument measures the resistance of the complete earthing circuit including the resistances of the consumer's earth and of the sub-station earth. In this test use is made of the neutral conductor from the sub-station to the consumer's premises (see Figure 1), and the instrument includes a neon lamp which lights up if connection has inadvertently been made to a live conductor instead of to the neutral. A press button short-circuits this lamp when a test is being made.

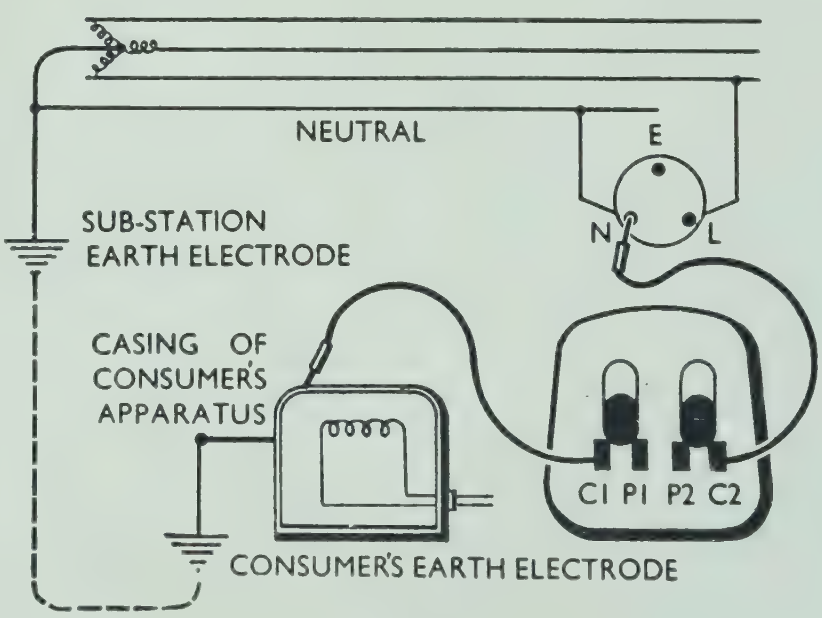


Figure 1.

In other respects the 'Megger' Earthometer Tester is identical with the series 4 'Megger' Earth Testers just described, and it therefore may be used as an earth tester for measuring the resistance to earth of an earth electrode.

Evershed Tank Contents Gauge†. (Figure 2) This gauge records at a distance the contents of tanks containing syrups, paper pulp, slurries, soap

or other viscous liquids. Troubles from contamination, heat, corrosion or viscosity are avoided as no moving mechanism comes into contact with the liquid.

It comprises a transmitter fitted near to the base of the tank and connected by two wires to one or more indicators or chart recorders installed at any convenient control centre.

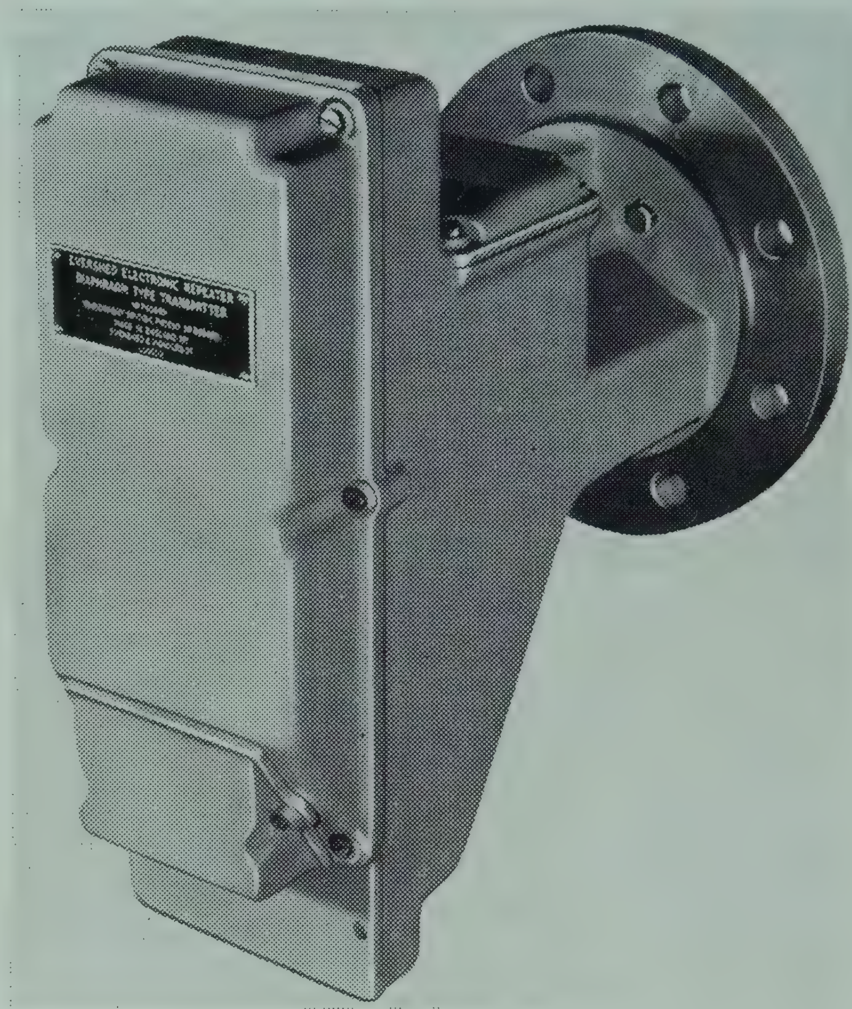


Figure 2.

The transmitter contains a diaphragm which is exposed to the pressure of the liquid in the tank. Through a system of compound levers the deflection of the diaphragm is opposed by the attraction of a coil by an electromagnet, the current through the coil being automatically varied so as to balance the pressure on the diaphragm. The current through the coil, which is therefore a measure of the tank contents, passes through the remote indicators and recorders which are connected electrically in series.

Servo and other F.H.P. Motors† (Figure 3). A selection of special fractional horsepower motors for D.C. and A.C. is exhibited. Those for use with servo mechanisms have a high torque–inertia ratio. Some of the motors include generators for providing a damping component proportional to speed, so as to increase stability and avoid hunting. The generators in the D.C. machines are of the permanent magnet type giving the minimum of ripple, whilst on the A.C. machines they are of the drag-cup type having therefore minimum inertia.

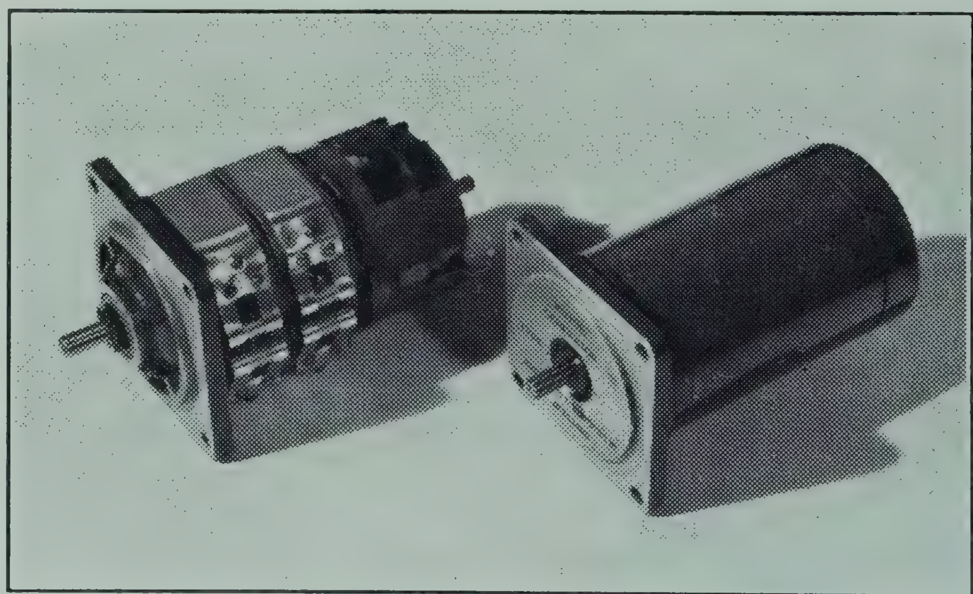


Figure 3.

The motors which are usually arranged for flange mounting, can also be supplied with integral gear boxes.

One of the D.C. motors exhibited (F.B.3) incorporates a secondary motor and fan to provide forced cooling. There are also constant speed D.C. motors of the governed type, with or without externally adjustable speed control. Synchronous A.C. motors are also exhibited.

Some technical data are given in the tables below.

D.C. Split-Field Servo Motors*

Frame Size	Moment of Inertia (oz. in^2)	Stalled Torque (oz. in.)	No load Speed (r.p.m.)	Remarks.
FP	0·5	6	7-8000	Motor.
FQ	0·72	8-9	7-8000	Motor.
FA	1·56	18	7-8000	Motor.
FB	2·03	30	7-8000	Motor.
FA_2	1·93	22	7-8000	Motor with built in D.C. generator. 15 v. per 1000 r.p.m.
FB_3	2·03	56-60	11-12000	Motor is forced air cooled by an integral blower.

*The motors exhibited have 80 ma. fields and 220 v. armature supply but they can be wound for other currents and voltages.

D.C. Permanent Magnet Machines

Frame Size	Moment of Inertia (oz. in^2)	Stalled Torque (oz. in.)	No load Speed (r.p.m.)	Remarks.
FF_2	0·5	6	7000	Small general purpose motor.
FF_1	0·5	—	—	D.C. generator 25v. per 1000 r.p.m. 1% ripple r.m.s.

D.C. Motors with Constant Speed Governors (20-110 v.)

Frame Size	Torque at full speed	Remarks.
FP_3	4·5 oz. in. at 2000 r.p.m.	Motor with fixed governor control.
FP_{36}	4·5 oz. in. at 2000 r.p.m.	Motor with externally adjustable Governor control (500-3500 r.p.m.).

A.C. Servo Motors and Induction-Generators (50–60 c/s.)

Frame Size	Moment of Inertia (oz. in^2)	Stalled Torque (oz. in.)	No load Speed (r.p.m.)	Remarks.
FC	0·18	3·5	2800	2-phase motor.
FE	2·4	11·0	2800	2-phase motor.
FD	0·2	3·5	2800	2-phase motor with built in induction-generator 0·75v. per 1000 r.p.m.
FX_1	0·6	20-30	2800	2-phase motor with built in tacho-generator 0·75v. per 1000 r.p.m.
FC	0·02	—	—	Induction-generator, drag-cup type as fitted in types FD and FX_1.

A.C. Motors.*

Frame Size	Stalled Torque (oz. in.)	Synchronous or running torque (oz. in.)	No load speed (r.p.m.)	Remarks.
FC	0·7	0·7	3000	single phase synchronous motor.
FE_8	6·0	6·5	3000	single phase synchronous motor.
FE_{10}	11·5	20·0	2950	single phase induction motor.

*The motors exhibited are wound for 230 v. 50 c/s., but they can be wound for other voltages and frequencies.

Quick Response Duplex Recorder† designed to follow frequencies up to 10–15 c/s.

The instrument has a 6-inch chart giving two records each $2\frac{7}{8}$ in. wide. The chart is driven by a synchronous motor and speeds of $\frac{1}{2}$, 1, 3 and 6 in/sec. are provided by means of a four-speed gear box.

The complete equipment, which is servo-operated, consists of two units — the recording instrument and the driving amplifier. The latter comprises two amplifiers and a power pack in one unit operated from 230v., 50 c/s. supply. The amplifiers are controlled by the feedback from fine wire centre-tapped potentiometers which operate in conjunction with the moving systems of the recorder. The potentiometers have been wound to such a fine pitch that virtually stepless control has been achieved.

The recorder exhibited will be used to demonstrate the performance of a typical small servo-mechanism.

Stand 97

THE AUTOMATIC COIL WINDER and ELECTRICAL EQUIPMENT CO. Ltd.

Winder House, Douglas Street, London, S.W.1

Multi Range Electronic Testmeter† (Figure 1). The instrument shown is an improvement upon earlier models. It possesses an even greater degree of stability and incorporates various interesting alterations. The instrument is virtually two instruments in one — a stable and accurate high frequency valve voltmeter, and a 56 range thermionic test set for D.C. and power frequency measurements. It will measure A.C. and D.C. voltage, D.C. current, resistance, capacity and output power as simply as any ordinary multi-range measuring meter. It is well protected from damage by overload. The testmeter operates from normal A.C. supplies, and the mains input circuit renders the instrument free from variations due to mains fluctua-

Figure 1.

tions. The basic valve millivoltmeter bridge is so designed as to render it substantially independent of changes which occur when valves are renewed.

A diode circuit housed in a silvered probe is used for measuring A.C., the probe unit being removable from the main instrument for work at high frequency. A special circuit is used to offset the diode contact potential and allows the use of a linear scale on A.C. voltage measurement.

From a basic D.C. voltage range of 250 mv. with an input resistance of 11·0 MΩ the following ranges of voltage are obtained: 1·0, 2·5, 10·0, 25·0, 100·0, 250·0 and 1,000·0, each of which has the same input resistance of 11·0 MΩ. A multiplier resistance which increases the impedance of all ranges to 110 MΩ is provided and with its use all ranges of D.C. voltage are multiplied by 10.

The testmeter measures D.C. current in 10 ranges: 25 μa., 100 μa., 250 μa, 1 ma., 2·5 ma., 100 ma., 250 ma. and 1 amp. The millivolt drop on all ranges is 250mv.

The diode circuit may be used internally on A.C. voltage measurements up to 2 Mc/s. When used externally its useful range is extended to 200 Mc/s. The following ranges are obtained on the normal measuring terminals: 1, 2·5, 10, 100, 250 v. Using a special multiplier socket each range is multiplied by 10. The input resistance is 250,000 Ω with probe internal using normal terminals and 2·5 MΩ using the × 10 socket.

At high frequencies the probe is used externally and measurements may be made with high accuracy up to 200 Mc/s., the input impedance at 1 Mc/s. being equivalent to 1·5 MΩ with a shunt capacity of 6 pF.

Two capacity ranges enables measurements to be made from 100 pF. to 50 μF. Output power measurements can be made on two ranges having full-scale deflection of 500 mw. and 5 w. respectively. The internal load of the instrument on these ranges can be varied in six steps from 5 to 5,000 ohms. The decibel scale is calibrated against a zero level 0 db. = 50 mw.

Three resistance ranges enable measurements to be made from a fraction of an ohm to 10 MΩ, whilst an insulation range measures from 0·1 MΩ to a maximum of 1,000 MΩ.

Signal Generator† (Figure 2). This is an interesting example of a very moderately priced instrument giving laboratory performance over a frequency band of 50 kc/s. – 80 Mc/s. The instrument is directly calibrated, operates upon fundamentals throughout its frequency band, is accurate to within 1%, is highly stable, its output has harmonic content of less than 1%, it has excellent attenuator performance, the minimum signal being approximately 1μv., whilst high level signal output is substantially constant throughout the frequency range.

The visitor to the exhibition should particularly note the careful attention which has been paid to the mechanical

Figure 2.

construction of the instrument to ensure rigidity of components and good R.F. screening. An ingenious, illuminated automatic range and frequency indication avoids ambiguity, the instrument being compact, of pleasing modern design, self contained and available in both mains and battery models.

High Sensitivity Avometers† (Figure 3). *Type H.R.*1. This is a portable multi-range high sensitivity instrument. It is similar in appearance and weight to the standard Avometers, but has a specially sensitive movement to enable D.C. voltages to be measured on high resistance circuits.

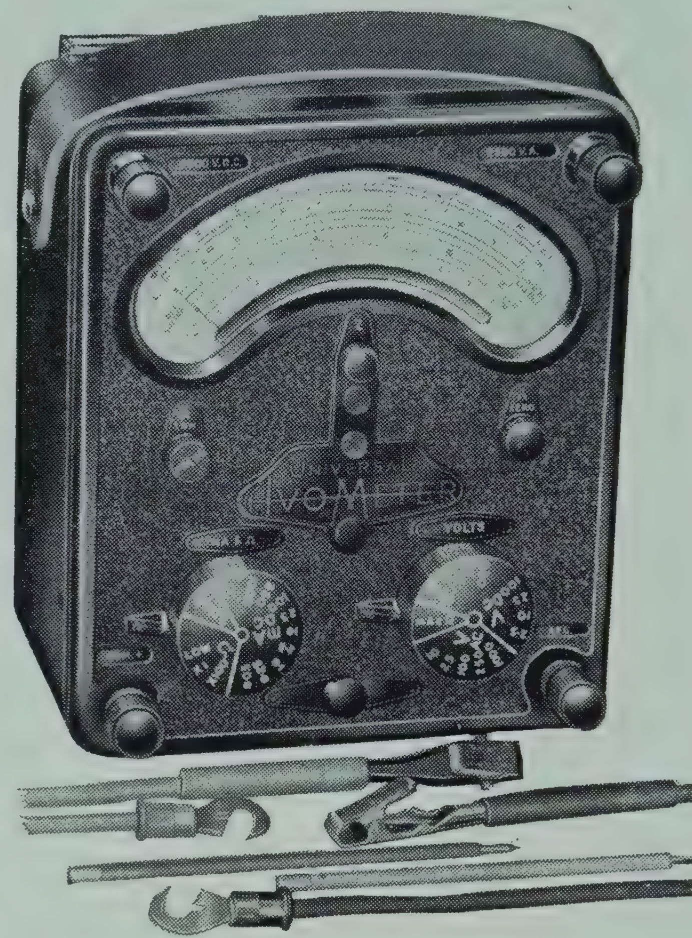


Figure 3.

The basic sensitivity is 50 μa. full scale, with a 5 in. scale length, giving a resistance of 20,000 ohms/volt on the D.C. voltage ranges. The instrument is fitted with the normal 'Avo' cut-out which protects the movement against damage by overload, and is unique in combining in one instrument a 50 μa. sensitivity with the safety factor obtaining in the normal 'Avo' instruments.

The instrument has seven D.C. ranges, from 2·5v. to 2,500v. at 20,000 ohms/volt, and six A.C. ranges from 10 v., to 2,500 v. at 1,000 ohms/volt ; D.C. current ranges of 50 μa. to 1 amp. are covered in nine steps, and resistance values from 0·1 ohm to 5 megohms are given in three self-contained ranges. The lowest resistance range is of the parallel circuit type, necessitating the pressing of a button for test, and in this case 1 ohm corresponds to 1 in. deflection.

The instrument is accurate to B.S.I. first grade limits on D.C. amps and A.C. volts, while on D.C. volts it is within 2% of the indication from full scale to half scale, and 1% of full scale value below half scale.

The instrument zero may be displaced to the extent of 30 divisions so that the meter can be used as a galvanometer on its 50 μa. range.

*H.R.*2. A similar meter differing only in the ohms ranges from the above is made. This has a series type low resistance range, and therefore does not call for the use of a press button for low resistance tests. While the scale is more contracted on this low resistance end, it still reads down to 0·1 ohm, but the top limit extends to 20 megohms. The ranges of both the types of High Sensitivity Meter can be extended by means of an external 10,000 v. D.C. multiplier.

Electronic Test Unit† (Figure 4). The measurement of small values of A.C. voltages, inductance, capacity and *Q* at radio frequencies has hitherto required the use of very expensive equipment, or the expenditure of considerable time operating laboratory ' hook-ups '.

For a reasonably small outlay, 'Avo' now bring the coverage of this field within the scope of the possessor of a Signal Generator and Valve Voltmeter. Although it may be used with any Signal Generator/Valve Voltmeter

combination, this instrument has been designed to suit the ranges of the Wide Range Signal Generator and the 'Avo' Electronic Test Meter.

Specification of the Instrument:

As a Wide Range Amplifier. The instrument is capable of a constant amplification factor of 40 ± 2-3 db. at all frequencies between 30 c/s. and 20 Mc/s., this coverage being split into five bands. The amplifier is aperiodic up to 2 Mc/s and flatly tuned from 2–20 Mc/s. Using the 'Avo' Electronic Test Meter on its 1 v. A.C. range, it is thus possible to make measurements as low as 2·5 mv. By inserting a series input capacitance of a very low order, it is possible with a reduced sensitivity to make comparative measurements of the H.F. voltages present in the I.F. stages of television receivers, with negligible loading and detuning. It is thus possible to observe the picture whilst making measurements.

Figure 4.

As a Capacity Meter. Measurement of capacity is made by the laboratory method of substitution ensuring a high degree of accuracy, coupled with the ability to measure very small capacities. Two distinctly calibrated ranges in combination with a calibrated decremental capacitor cover measurements from 0·5 pF. – 1,000 pF. The self-capacity of coils can also be measured.

As an Inductance Meter. The variable reference capacitor is calibrated in such a manner that at suitable frequencies given, direct measurement of inductance from 0·5 μH. – 50 mH. may be made. Six ranges are provided giving a total calibrated scale length of approximately 40 inches.

As a Q Meter. A small decremental capacitor is provided enabling the *Q* of R.F. coils to be measured at frequencies up to 20 Mc/s. The accurate and simple standard laboratory decremental method of measuring *Q* has been adopted in this instrument.

Finish. Grey crackle enamel. Silvered terminals.

Heavy Duty Avometer† (Figure 5). This is a multi-range A.C./D.C. instrument specially designed for use under difficult conditions where a robust and portable instrument is required. The meter incorporates an automatic cut-out mechanism which affords protection when electrical overloads are inadvertently applied to the instrument, whilst an indicator appears through an aperture in the scale and shows the user that the overload

Figure 5.

mechanism has tripped. After the cause of the overload has been removed, the turning of a small control upon the instrument panel immediately restores the cut-out and renders the meter again ready for use.

Eighteen self-contained ranges are provided, all using one common pair of terminals, range selection being obtained by means of a single rotary switch. The instrument is of the moving-coil type, employing a transformer/rectifier system for A.C. measurements. The scale is approximately $3\frac{1}{4}$ inches in length and is suitably marked to present direct indication of the ranges which follow.

A.C./D.C. volts	10, 25, 250, 1,000.
A.C./D.C. current.	10 ma., 100 ma., 1 amp., 10 amps.
Resistance.	0-500 ohms (mid scale 12·5 ohms).
	0-50,000 ohms (mid scale 1,250 ohms).
Sensitivity.	D.C. voltage ranges, 1,000 ohms per volt.
	A.C. voltage ranges, except 10 volt range, 500 ohms per volt.
	10 volt A.C. range, 200 ohms per volt.

Accuracy on D.C. to within 1% of full scale value.
Accuracy on A.C. to B.S. first grade.

The meter is supplied with a pair of stout leads complete with interchangeable clips and prods.

It is possible to extend the ranges of this meter by means of suitable external shunts, transformers, and also a Resistance Range Extension Unit, which will enable values to be read down to 0·01 ohm. All these accessories are supplied by the company.

A special version of this instrument is available, provided with voltage and current ranges chosen for their suitability in Railway Track Signalling Service.

A specially designed leather case can be supplied which offers excellent protection to the instrument, rendering it readily portable, yet ready for immediate use whilst still lying in its case.

Testmeter Type 'W'†. A model is shown of an advanced multi-range electronic testmeter of much wider specification than the Electronic Testmeter and providing in all some 80 ranges of measurement.

This has been specially developed to conform to requirements of radio laboratories and a special circuit is incorporated which virtually overcomes the effects of random valve contact potential fluctuations, and thus provides an exceptional long and short term zero stability.

Beside voltage, current and resistance ranges similar to those of the Electronic Testmeter, 250 mv. A.C. range and A.C. current ranges from 1 ma. full scale to 2·5 amp. full scale have been included ; these are useful at low radio frequencies. The watt ranges have been extended to give the enormous range of 5 μw. to 5 watts in six different load resistances. The overall design of the instrument is such as to be suitable for general service use.

Universal Bridge† (Figure 6). The instrument is a self-contained 50 c/s. Bridge having in all 20 calibrated ranges for the measurement of resistance, capacity and inductance, over an extremely wide range, and to a high degree of discrimination.

The value of the unknown impedance is directly indicated on a single clearly marked scale, together with suitable multiplier, the total effective

calibrated scale length being thus approximately 240 in.

Further provision is made for measuring the leakage of condensers, both electrolytic and solid dielectric type, by the flashing neon method, D.C. test voltage being available between the limits of 25 and 450 V. D.C. Balance indication is clearly and definitely made by observation on a panel movement, thus avoiding the difficulties and uncertainties met with in other visual and oral methods.

Figure 6.

General Specification :

Resistance Ranges : 8 directly calibrated ranges, covering 0·5 ohm to 50 megohms. Mid scale accuracy to within $\pm$ 2%.

Capacity. 8 directly calibrated ranges, covering a nominal 5 pF. to 50 mF., mid scale accuracy being to within approximately $\pm$ 2%, with a correction for minimum capacity on the lowest capacity scales.

Inductance. 50 mH. to 500 H. in four ranges.

Phase Control. A continuously variable phase balance control is provided operative as a power factor control over all capacity ranges, and as a *Q* control on inductance ranges.

An additional Bridge range is provided enabling the calibrated scale to be used in conjunction with external standards as a percentage comparison scale.

Condenser Leakage. Directly indicated by flashing neon method at 6 D.C. test voltages, i.e., 25, 50, 150, 250, 350 and 450 volts.

Balance Indicator. Sensitive amplifier Valve Voltmeter feeding panel movement, provided with variable panel sensitivity control so that balance sensitivity can be varied to suit the measurement under consideration. Logarithmic scale shape provides high balance sensitivity together with ease of identification and freedom from overload.

Power Supply. 100 – 110 volts, and 200 – 250 volts A.C. mains 50 c/s.

Exposure Meter† (Figure 7). This instrument is a double range photoelectric instrument of attractive appearance and operating characteristics.

In use it is merely necessary to rotate a knob which carries the exposure time scale until a mechanical pointer lies over the electrical one. This operation automatically causes a perforated shutter to rise in front of the cell on the high range. The exposure time can then be read off against the desired 'f' number.

The film speed is in the new B.S. system, and a presetting adjustment is provided.

The limits of brightness are from $\frac{1}{8}$ to 2,000 candles/ft^2, and it is possible to read off the brightness on the time scale if desired. The time scale is

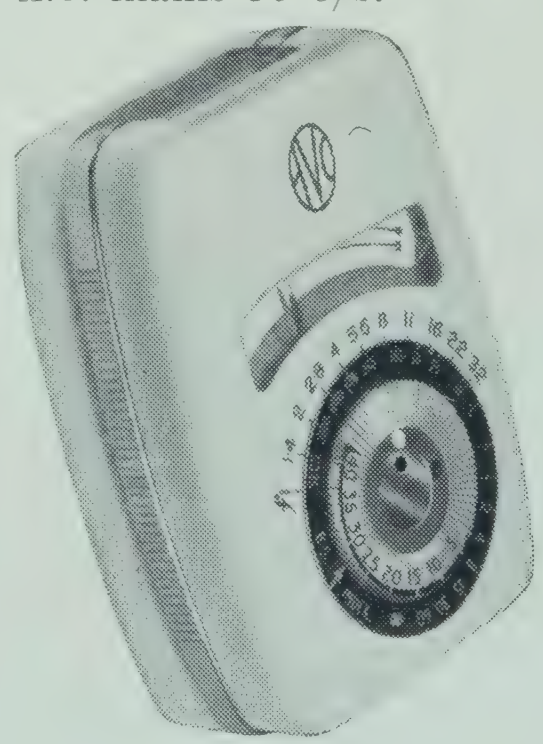


Figure 7.

marked from 1/2,000 sec. to 60 sec. with a special mark for cine speed, while the 'f' values are from f/1 to f/32.

A sling is provided with the instrument.

The size of the instrument is $3\frac{1}{4}$ in. × $2\frac{5}{16}$ in. × $1\frac{1}{4}$ in., and its weight 9 oz.

Light Meter† (Figure 8). A pocket size photo-electric instrument giving direct indication of illumination in foot candles and lux.

Figure 8.

The meter has two ranges, selection being by means of a switch which at the same time indicates the multiplying factor to be used. The scale is marked 0–50 foot candles, and 0–500 lux, the scaling being of logarithmic form which enables readings of 1 foot candle to be easily made. This range covers practically all measurements commonly required, but to meet the exceptional needs of certain situations, a × 5 multiplier extends it up to 250 foot candles and 2,500 lux.

In order to measure light coming from different angles without the risk of interposing the shadow of the user, the photocell is hinged at the end of the case so that it can be inclined at any angle between horizontal and vertical.

The calibration is suitable for either tungsten filament, or incandescent gas lighting, and for other forms of illumination such as fluorescent, for which multiplying factors are provided.

Electronic Insulation Resistance Meter†.

General Description. This is a self-contained instrument, powered from 50 c/s. A.C. mains for the measurement of insulation and break-down resistance with D.C. applied voltage. It consists essentially of a high voltage supply giving a test voltage of 500 v. D.C. which is applied to the sample, a series of high accuracy reference resistances, and a multi-range bridge type thermionic D.C. millivolt meter.

The mains supply to both the test voltage and the millivolt-meter power supply is stabilized ensuring constancy of zero and calibration despite possible mains fluctuations.

Insulation resistance readings are made direct on two clearly calibrated scales of a 4 in. meter. A single calibration with three-decade multiplier settings covers the range 0·05 MΩ – 2,500 MΩ without making use of the first 10% of the scale where readings are crowded. A fourth range gives a specially expanded scale covering 2,500 – 250,000 MΩ.

A safety press button with warning light is provided to minimize the possibility of shock due to the comparatively high test voltage, whilst the test terminals are of special long path type to minimize error due to surface leakage. The whole instrument is housed in an attractive metal case with protective panel bars.

Ranges.	(1)	0·05 MΩ — 25 MΩ ;	Centre scale	2·5 MΩ.
	(2)	0·5 MΩ — 250 MΩ ;	,, ,,	25 MΩ.
	(3)	5 MΩ — 2,500 MΩ ;	,, ,,	250 MΩ.
	(4)	2,500 MΩ — 250,000 MΩ ;	Expanded scale.	

Accuracy. Centre scale within 5%.
Calibration. Direct in MΩ.
Controls. Range Multiplier, Set Zero, Set Test Volts, ON/OFF, Safety button.
Power Supply. 200–250 v. 50 c/s. A.C.

Precision Valve Voltmeter† (Figure 9). This is a laboratory type valve voltmeter with a directly calibrated 5 in. mirror scale in which special precautions have been taken to maintain a high degree of accuracy and stability; it has excellent R.F. characteristics. The instrument is portable and operated from 50 c/s. A.C. mains.

Figure 9.

Figure 10.

Valve Characteristic Meter† (Figure 10). This meter will test any standard receiving or small power transmitting valve on any of its normal characteristics, and under conditions corresponding precisely to any desired set of D.C. electrode voltages. Since only A.C. voltages are used throughout the tester, the inherent regulation troubles and inaccuracies associated with D.C. working are eliminated. The instrument, which operates from 110–250 v. A.C. 50–60 c/s. is of very compact size.

The multiple selector switch feature is retained, whilst the valve panel, an integral part of the tester proper, contains valve holders covering all the latest valve developments.

Heater voltages from 1·1 to 126 v. are available, and inaccuracy due to mains voltage is overcome by the provision of a panel adjustment which enables the applied volts to be accurately adjusted.

The great value of this Characteristic Meter is that any family of valve characteristic curves may be obtained by its use. The use of A.C. electrode voltages supplied from a low impedance source eliminates the inaccuracies that occur when rectified A.C. is used as there is only a minute change of V_a or V_{g2} when the I_a or I_{g2} is varied. This feature obviates the necessity for continuously metered controls, and ensures that electrode voltages will be correct irrespective of valve types and test conditions.

Valves with two electrode systems can be checked at each anode by a simple change-over switch, the anode under test being maintained at a reasonable electrode voltage.

Simple switches provide tests for inter-electrode leakage with cathode, hot and cold, gas test, etc. An extremely useful feature is the test given to rectifying valves, which are tested on each of their anodes separately at the full rated load and with an 8 μF. reservoir capacitor in the circuit.

A specially developed polarized relay is incorporated which prevents damage to the instrument due to overloading the H.T. circuits either by incorrect adjustment or misuse. It will save the heater of a valve to which the H.T. or screen voltage has been inadvertently applied. Operation of the cut-out is shown by the removal of the meter illumination. The instrument is quickly set up by a single circuit selector switch which automatically removes from the circuit any voltages or controls which are not required for the test.

Universal AvoMinor Model 2†. This instrument is a development from the well known Universal AvoMinor which has for many years been well known throughout industry. The instrument incorporates the following ranges :

5, 25, 100, 200 and 1,000 V. A.C. and D.C. at 4,000 ohms per volt.

1, 5, 25, 100, 500 milliamps D.C. and 0–20,000 ohms with a mid-scale reading of 4,000 ohms and first indication of 100 ohms.

The 1 milliampere range corresponds to a 100 millivolt drop and can be used with suitable external shunts to extend the current range whilst a low range resistance extension unit having two ranges, 10 and 100 ohms enables readings to be taken down to one ohm. Higher resistance ranges than that presented by means of the internal battery can be obtained by using external A.C. or D.C. voltages.

Stand 98

BRITISH AMERICAN RESEARCH Ltd.,

Block E2, Hillington, Glasgow, S.W.2

High Vacuum Apparatus. The following will be among items exhibited : B6 Booster Diffusion Pump ; Alphatron Ionization Gauge ; Emission Stabilized Ionization Gauge ; Metal Ionization Gauge ; Rotary Bellows Seals ; Vacuum Valve ; Photograph of Vacuum Melting Furnace ; Photograph of 3103 Metallization Unit.

Stand 99

MUIRHEAD & CO., Ltd.,
Elmers End, Beckenham, Kent

Muirhead-Pametrada Wave Analyser D-489-A†. This analyser is of the degenerative feedback type with resistance capacitance tuning. A constant selectivity is obtained at all tune frequencies, as distinct from the constant bandwidth of the heterodyne type of analyser. Tuning is from 19–21,000 c/s. in three decade bands (with overlap) each band being subdivided into three. The main tuning control is a 72 stud rotary switch covering the range 19-88 c/s. in steps of 1 c/s. to which may be added 60 or 120 c/s. the correct frequency being indicated by a shutter mechanism. In addition a fine control gives 0-2 c/s. to obtain intermediate readings.

To facilitate tuning to a signal of slightly variable frequency a band-pass control is available, giving 3% or 10% 'flat tops' at all frequencies.

The maximum sensitivity of the instrument is such that a signal of 3 mv. r.m.s. gives full meter deflection. An input attenuator enables a maximum input of 10 v. to be used. The meter normally reads average values, but can be switched to read peak values below or above average if required. For oscilloscope work the output is brought out to terminals, and phone jacks are also provided. It should be noted that the output voltage is the same frequency as the input, and not an intermediate frequency, as with heterodyne analysers.

At maximum selectivity setting the total effective Q is 80. The accuracy of frequency setting is $\frac{1}{2}$%, and the frequency response is constant within $\pm$ 2 db. over the whole range.

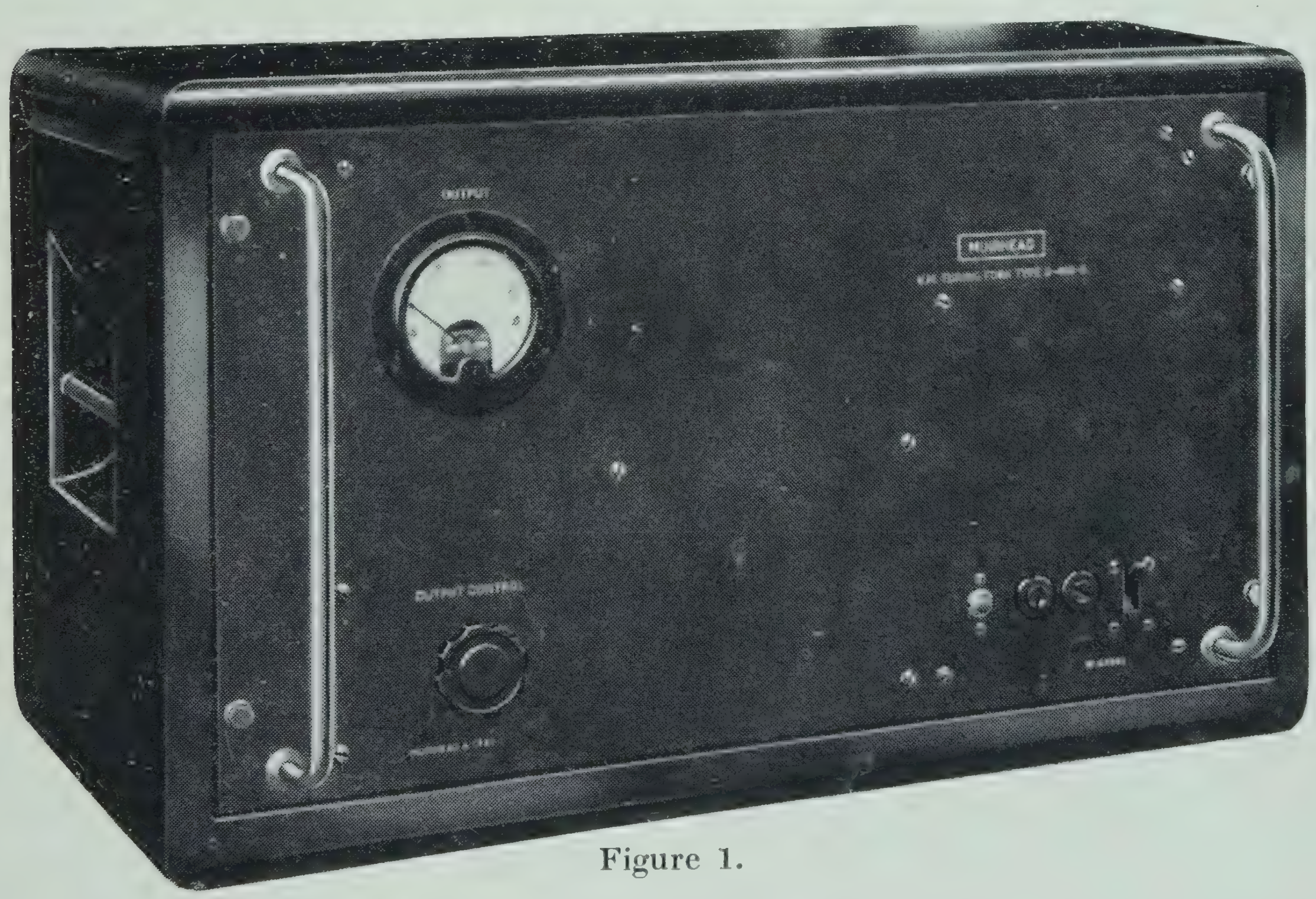


Figure 1.

Low-Frequency Valve-maintained Tuning Fork, Type D-418-D† (Figure 1). The fluctuation in mains frequency which may occur during peak load periods has resulted in a demand for an independent 50 c/s. frequency standard. The low-frequency valve-maintained tuning fork Type D-418-D has

been developed to meet this requirement, and also to satisfy a more specialized need for a precision low-frequency standard. Forks with frequencies of 50, 100, 150 and 200 c/s. can be supplied.

The tuning fork is made of a special steel which has a low temperature coefficient of frequency. This is reduced still further by means of a carefully controlled heat treatment and ageing process. The fork is accurately balanced, and supported by a resilient mounting to absorb anti-nodal vibrations. This overcomes the necessity for a heavy metal frame.

The conventional two valve cathode-follower drive circuit is employed, but no negative feedback is used. The gain of the first valve is controlled by an A.G.C. circuit with the normal diode arrangement to provide the control bias. Low-frequency forks have an amplitude instability by virtue of their relatively large mass compared with the base mounting, and the A.G.C. circuit minimizes this effect.

The output circuit supplies ample power to feed a mains electric clock, or a timing device driven by a clock motor.

The frequency instability from all causes is less than $\pm$ 50 parts in 10^6.

The instrument is arranged to work from A.C. mains, 200-250 v., 50 c/s. The power consumption is approximately 70 watts.

Dimensions. 19 in. $\times$ $12\frac{1}{4}$ in. $\times$ $10\frac{1}{2}$ in. deep. (47·2 cm. $\times$ 31·1 cm. $\times$ 26·7 cm. deep).

Weight. 50 lb. (22·5 kg.).

Miniature Standard Cell, Type D-550-A† (Figure 2). The Miniature Standard Cell is of the saturated acid type, and as such employs cadmium amalgam and mercury electrodes, with an electrolyte of saturated cadmium sulphate solution. Whereas, however, in most cells of this type, the electrodes are each contained in the bottom of one leg of an H, this miniature cell consists of a single glass tube, the electrodes lying side-by-side in the base separated by a glass web. By this means the size and weight are reduced considerably, the unit is mounted in a moulded container only $\frac{7}{8}$ in. square by $3\frac{1}{2}$ in. high. Two spills are provided on the top of the container to which soldered connections can be made. The length of the internal connection avoids any risk of damage to the cell by heat from the soldering iron.

The internal resistance of the cell is approximately 750 ohms at 20°C.

The E.M.F. of this cell is the same as all saturated acid Weston cells, namely 1·01859 volts absolute at 20°C. This E.M.F. is guaranteed to within + 110μv. and –90μv. at 20°C. for individual cells. The temperature coefficient of E.M.F. is approximately –0·00004/°C. between 15°C. and 25°C.

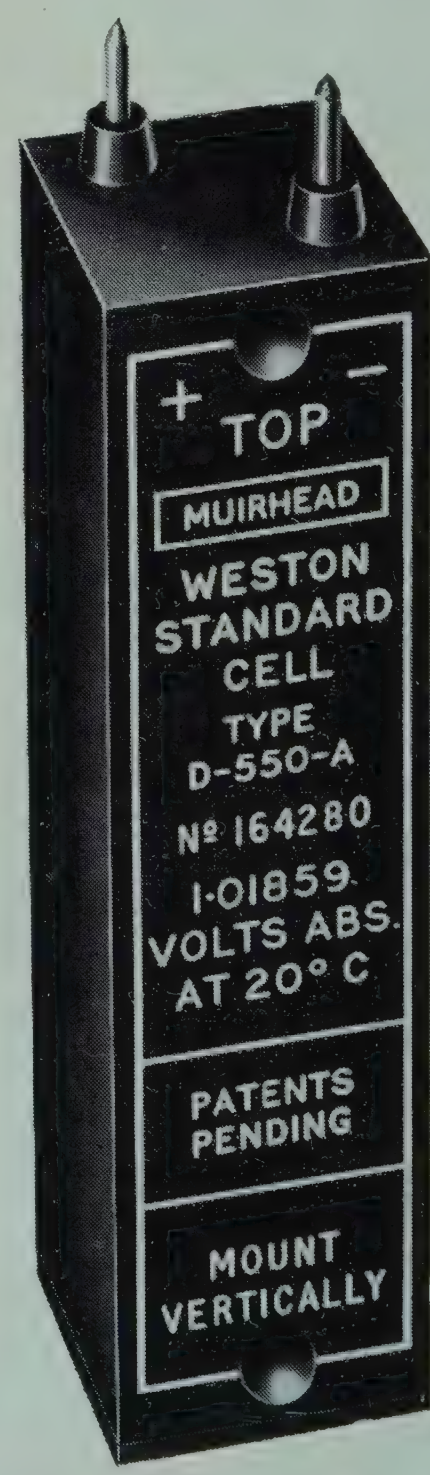


Figure 2.

With the classical construction it is quite easy for one leg of the H (and hence one half-cell) to attain a temperature several degrees in excess of the other. As the temperature coefficients of the two half-cells are relatively

large this results in an appreciable change in E.M.F. By mounting both cells in the same glass tube, the possibility of a temperature difference between them is reduced, and as the temperature coefficients, although large, are different in sign, changes in E.M.F. are largely eliminated.

Weight. 2·6 oz. (75 gm.).

High-Frequency Hysteresis Motors†. Self starting motors are shown for operation from audio-frequency supplies.

The rotor speed when fed with 1,000 c/s. is 10,000 r.p.m., but all types have built-in reduction gear boxes.

The smallest, which is used for checking the frequency of a 1000 c/s. signal against time, has a seconds contact. Larger motors provide output spindles with a torque up to 20 oz. in. at 300 r.p.m.

Models are available with power consumptions of from 2 to 25 watts.

Oscillograph, Type D-365-A† (Figure 3). This oscillograph element is of the Duddell type employing an oil-damped bifilar suspension, operating at frequencies up to 1,000 c/s. By careful design of the magnetic circuit and the use of modern magnetic materials a flat frequency characteristic has been obtained over this range, while still maintaining the sensitivity at a reasonably high figure.

Figure 3.

A Ticonal magnet is used, together with pole pieces designed to concentrate the flux with the minimum of leakage. The flux density in the air-gap is of the order of 10,000 lines/cm².

The suspension takes the form of a single phosphor-bronze strip doubled back on itself over a tensioning pulley, so that the two halves run parallel to form a bifilar suspension. Secured to the strips at the centre of the pole piece is a plane surface-silvered mirror measuring 0·030 in. × 0·060 in. × 0·010 in. thick.

The D.C. resistance is approximately 11 ohms, and the sensitivity is 0·65 mm. per ma. at a distance of 60 cm. The maximum current should not exceed 150 ma.

Dimensions. 3⅜ in. high × 2¼ in. wide × 3 in. deep. (8·6 cm. × 5·7 cm. × 7·6 cm.).

Weight. 2½ lb. (1·1 kg.).

High Resistance Universal Units, Type D-558-C† (Figure 4). These units are the most recent addition to our range of Universal units. Each unit comprises 4 – 500,000 ohm resistance bobbins Type D-177 connected in series, mounted in the standard 'Universal' moulded case. Five such units are bolted together to form a 10 megohm resistor. A stability of ± 0·5% is claimed but a recent N.P.L. test shows that this is a conservative figure. Four 10 megohm units were checked over a period of 4 days at constant temperature, and at no time during the test did the resistance value change by more than 0·01%. High insulation pillar

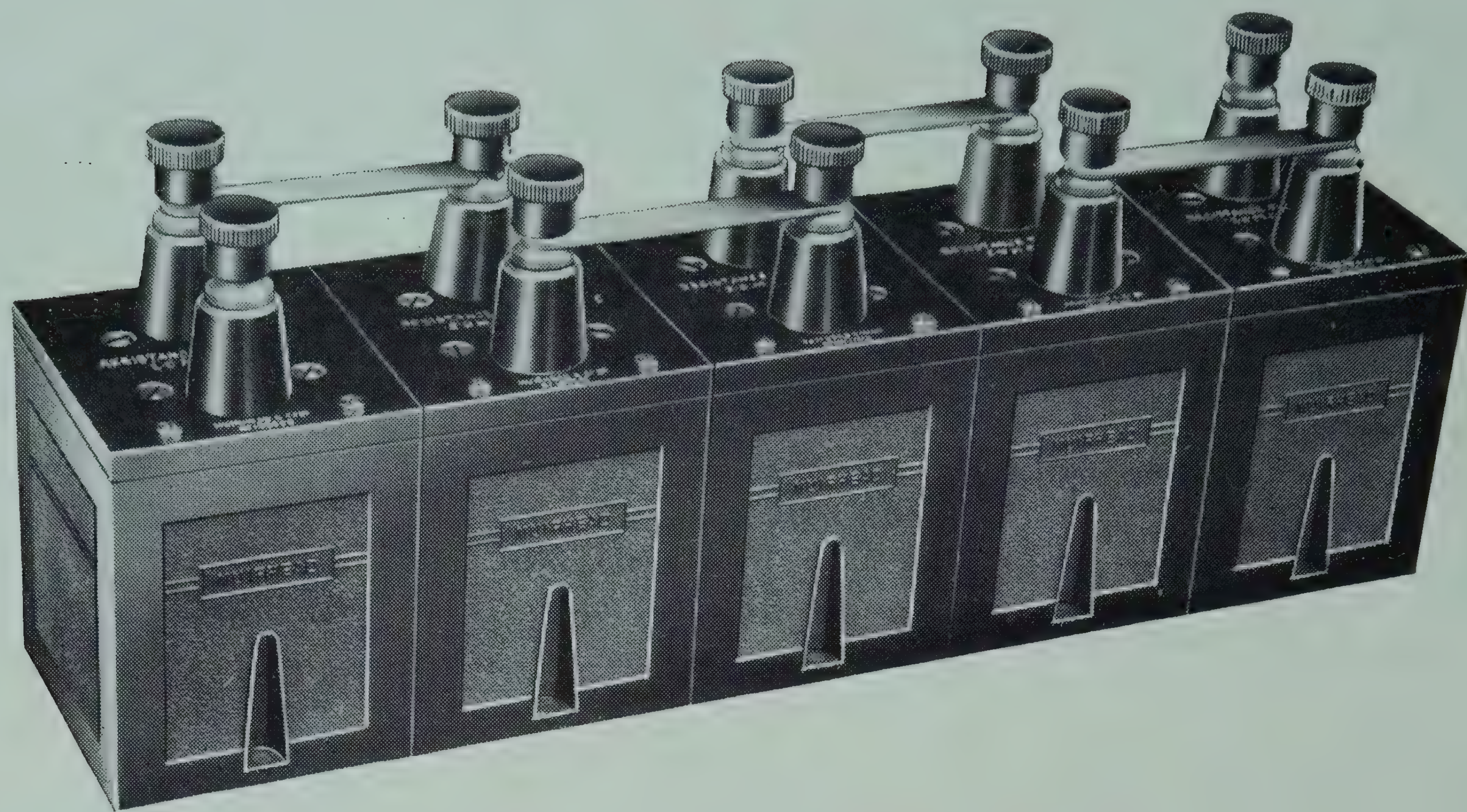


Figure 4. High Value Fixed Resistor, Type D-558-C.

terminals are fitted, and the N.P.L. report gives the insulation resistance between the resistance element and a metal plate on which the unit was standing as 8×10^4 megohms.

Stand 100

W. EDWARDS & Co. (LONDON) Ltd.,
Worsley Bridge Road, Lower Sydenham, London, S.E.26

Small Vacuum Coating Plants.

Model 6E — Accessory for Cathodic Sputtering and Cathodic Etching of Metallurgical Specimens† (Figure 1). A Cathodic Sputtering accessory has recently been developed for the Model 6E miniature evaporating unit which has considerably extended the experimental value of the plant; for example, the etching preparation of metallurgical specimens for visual microscopy and replica examination by electron microscopy. The specimens are etched by bombardment with positive ions in a glow discharge as described in recent reports in the literature. DEMONSTRATION.

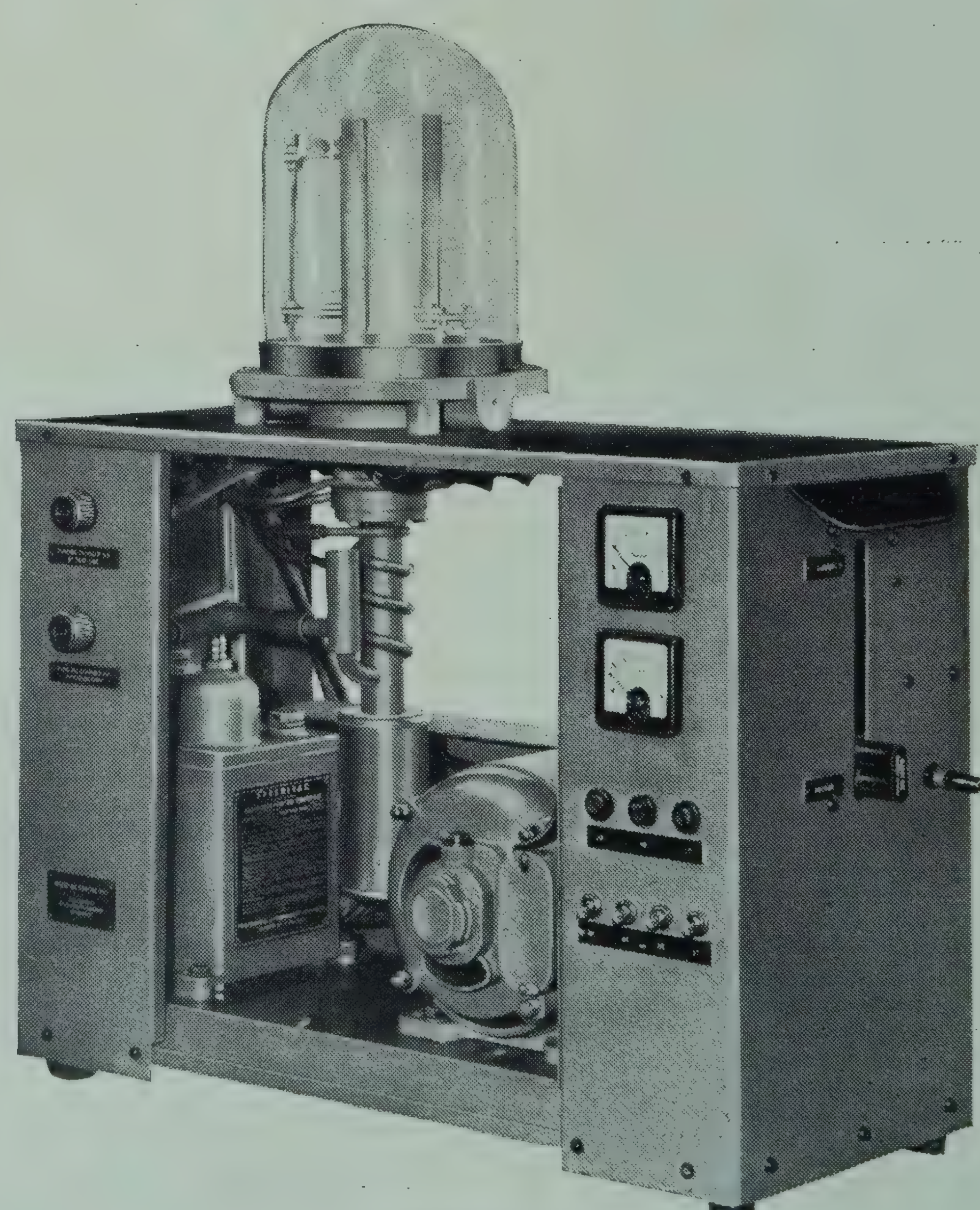


Figure 1.

Model 12E Shadow Casting Accessory†. A Shadow Casting accessory has been specially designed for the Model 12E Coating plant, this model having proved particularly suitable for such an important electron microscopy technique.

The work holder of the auxiliary is conveniently adjusted for height and inclination, the angle between the specimen surface and the evaporating source being measured by a protractor secured to the workholder. Maximum distance between the specimen and source is 22½ cm. The specimens are secured in a demountable clamp which can be conveniently used for holding the specimens during other processing. To overcome the hazard of handling embrittled filaments when they have to be changed for different evaporations, etc., the evaporation source is carried by a rigid assembly of copper extension electrodes which can be readily removed from the baseplate connection. DEMONSTRATION.

Figure 2.

Diffusion Pumps

Oil Type†. The range of Oil Diffusion Pumps exhibited last year now includes a 16 in. diameter *four-stage* pump having a speed of 5,000 to 6,000 litres per second and like all the pumps in the range beyond one inch size incorporates an integral booster stage to reduce the size of backing pump and associated pipelines. This new pump will be exhibited with its associated high speed isolation valve.

Fractionating†. A self-purifying metal pump operating with an interesting new fractionating arrangement and capable of attaining ultimate pressure of the order of 10^{-7} mm. Hg will be shown. The pump is 2¼ in. bore, has a speed of 70 – 80 litres per second and a maximum backing pressure of 0·5 mm. Hg.

DEMONSTRATION.

Mercury Type†. The range of pumps exhibited last year has been extended to include a new 1 in. bore laboratory pump which will be exhibited with its associated high vacuum valve.

Type GM.2 Glass Mercury Pump†. A new two-stage precision made glass pump with integral condenser will be exhibited with associated vacuum connections and liquid air trap. The pump has a speed of 12 litres/second and backing pressure of 1 mm. Hg.

Rotary Vacuum Pumps†. To provide suitable backing pumps for the larger diffusion pumps, the 'Speedivac' range of mechanical pumps has been extended by the single stage Model 1S450A (Figure 3) having a displacement of 15 ft^3/min. (450 litres/min.) and ultimate vacuum of 0·005 mm. Hg (McLeod Gauge). It embodies various features of the new 'Speedivac' pumps exhibited last year including integral spray arrestor, oil level indicator, easy drainage facility, small oil supply, quiet valve, light alloy construction.

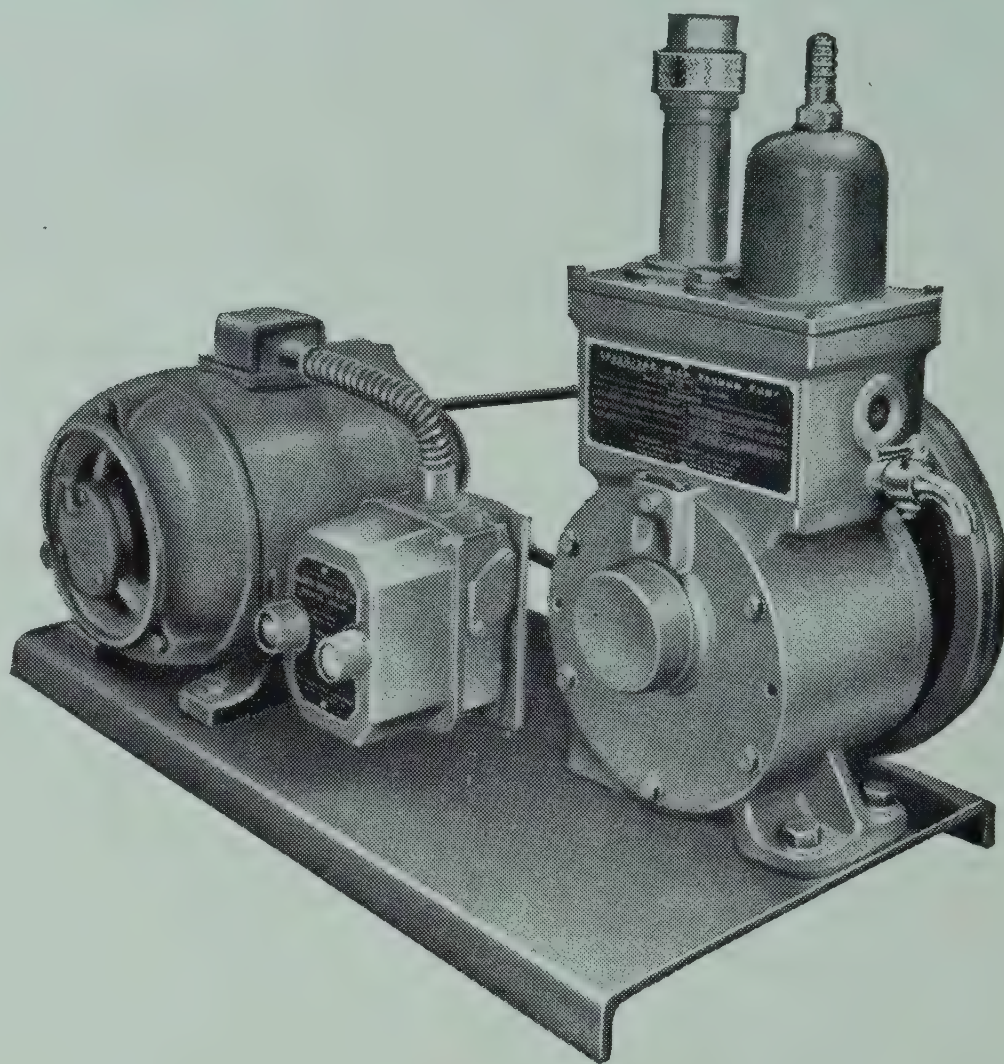


Figure 3.

Water Jet Pump with Non-Return Valve†. The annoyance of water return into the vacuum system from water jet pumps as a result of unsteady or failing water supply has given rise to many unsuccessful non-return valves. A simple, cheap and reliably effective valve in no way affecting the performance of the pump is now available which moreover can be added to all Edwards' pumps now in use. DEMONSTRATION.

Vacuum Gauges.

Philips Gauge of Improved Sensitivity†. The sensitivity and low pressure range of the Penning Gauge (*Physica* 1937, **4**, 71) can be considerably improved by increased physical dimensions. The necessary precautions for low pressure determinations are now widely appreciated and these include avoiding tubulation errors with gauges which influence equilibrium conditions. Advantage is, therefore, taken of the increased gauge diameter — $2\frac{3}{4}$ in. — to have a vacuum connection of this size, thus giving a 'high-speed' gauge.

The gauge has been calibrated to 5×10^{-7} mm. Hg, the calibration being linear at these low pressures. The current is large enough to use standard meters (e.g., 12·5 μa. at 10^{-6} mm. Hg). The gauge will have many applications as a robust instrument for low pressure processes. DEMONSTRATION.

Combined Philips and Pirani Type Gauge†. To meet the need for vacuum measurements over the range normally covered by both the Philips and Pirani

types, a combined unit is now available forming a convenient, compact, economical gauge covering the range 10 mm. to 10^{-5} mm. Hg.

Miniature Pirani Gauge†. The inexpensive lightweight Pirani type gauge shown in prototype form last year is now in production in portable and panel mounting versions with and without leak detection facilities. The unit operates from an integral dry battery or a miniature plug-in mains power unit. The meter is calibrated from 0·5 to 0·001 mm. Hg.

Improved Low Pressure McLeod Gauge†. The mercury container has been increased consistent with convenience and safety to extend the low pressure range to 10^{-6} mm. Hg. The gauge is air operated and accurate readings are assisted by a needle valve for fine control of the air supply, a silvered scale and cursor with magnifying lens.

Cold Cathode Vacuum Indicators†. The prototype gauges exhibited last year are in production and provide direct reading mains operated units for approximate indications in the ranges :

Type NP-1 : 10^{-3} .. 10^{-4} mm. Hg.
Type ND-1 : 1 .. 5×10^{-2} mm. Hg.

Specially designed discharge tubes are employed for the gauge heads (Type NP-1 employs the Penning principle with magnetic field) and neon tubes for vacuum readings, the glow length being calibrated in pressure units. DEMONSTRATION.

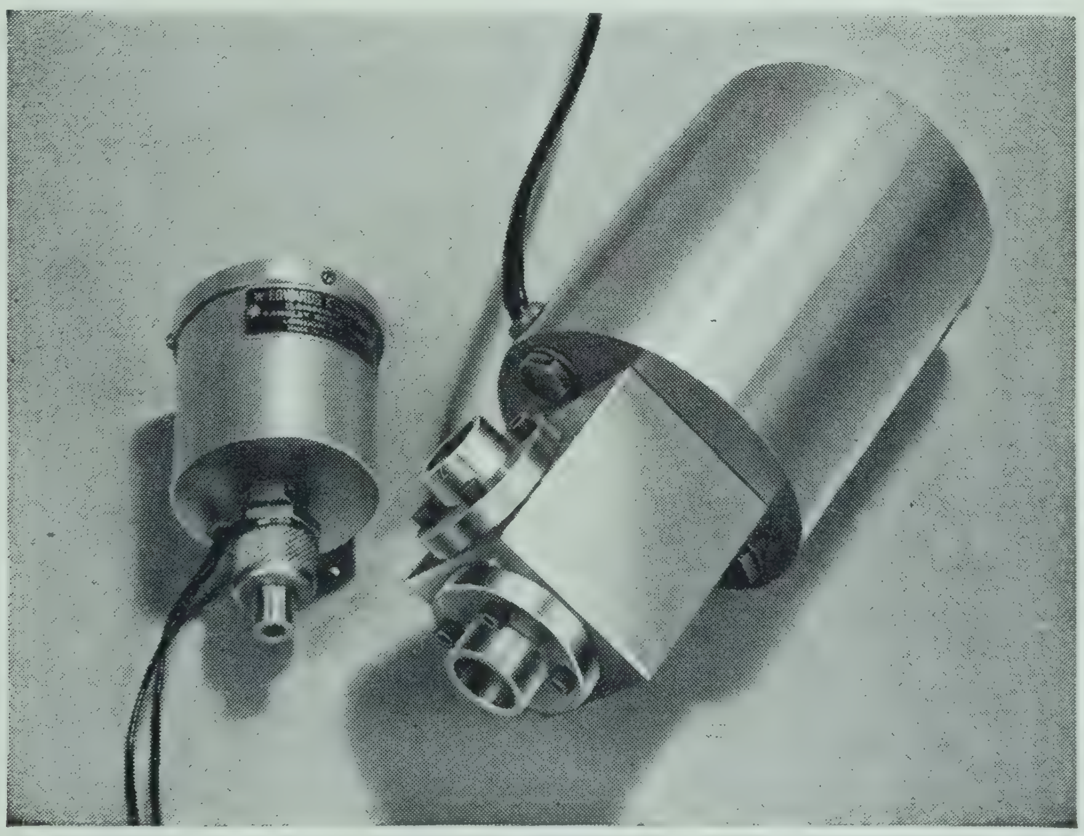


Figure 4.

Magnetically and Compressed Air Operated Valves† (Figure 4). Hitherto only very small bore magnetic valves for experimental work or unsatisfactory adaptations of magnetic valves designed for other services have been available for vacuum needs. Magnetic Valves specially designed for vacuum work including 1 in., $\frac{1}{2}$ in. and $\frac{1}{16}$ in. bore are exhibited including patterns with an auxiliary valve that automatically admits air into the rotary pump, to prevent oil backing up, when the main valve isolates the vacuum system.

Air operated valves are also proving valuable for automatic vacuum systems

since the master controller is easily devised and large forces are available with relatively small actuators. Examples of such valves will be seen in the automatic pumping unit demonstrated.

Vacuum Controller — Thermal Conductivity Type†. This device enables a series of events to be initiated by pre-set pressures in a vacuum system. It has been successfully used, for example, in controlling the operation of vacuum valving and crucible heating in coating plants.

A constant current is passed through a spring tensioned filament of special alloy, which actuates a pair of tungsten contacts as thermal and expansion changes follow pressure variations. The contacts are in series with an output multiple contact relay.

The filament supply is taken from a potentiometer pre-set to the pressure at which the first event is to occur. For subsequent events at different pressures, the closing of the output relay switches, via relays, the filament on to other potentiometers pre-set to the required pressures.

Automatic Pumping Plant† (Figure 5). An example of a self-contained Unit suitable for the continuous production of electronic devices, vacuum coating, vacuum brazing, etc., which can be built up in numbers to suit the particular automatic scheme, e.g., line or rotary travel is exhibited.

The form of the vacuum chamber or processing system depends upon the application. The Unit demonstrated has been devised for aluminizing cathode-ray tubes. It consists basically of a rotary pump, oil diffusion pump with baffle valve, by-pass and roughing valves, air release valve and evaporating arrangements. The plant is designed for compressed air operation, the master controller for which can be operated by a timed cam system for stationary Units or suitably spaced strikers, in the case of moving Units.

Figure 5.

DEMONSTRATION.

High Frequency Vacuum Testers†. The High Frequency Tester is indispensable for checking vacuum-tightness and degree in glass systems and components. It is also a convenient and inexpensive source of high-voltage discharge, for example, insulation testing and educational demonstrations.

Two new models have been developed to meet shortcomings of hitherto available testers, both of which have most conveniently handled light-weight moulded probes with thumb operated mains switch and output control.

Model T1 is a single piece tester, the probe moulding housing the complete H.F.

system. It will produce for continuous operation up to a one inch spark at relatively low frequencies.

Model T2 is a two piece tester using an external transformer unit. The output frequency is sufficiently high to prevent perforation of fragile glasswork and the discharge electrode can be held without uncomfortable results.

Vacuum Hot Plate†. An unusual vacuum oven has been developed consisting essentially of an electrically heated hot plate and a metal radiation cover, which form an oven within an evacuated glass bell jar. The hot plate is supported on the bell jar base plate the latter having connections for vacuum pump and gauge; an 'L' shaped bell jar gasket is used.

The radiation enclosure in vacuum produces a high degree of temperature uniformity over the hot plate which together with an integral energy regulator enables a controllable heated vacuum oven to be simply and cheaply obtained and in a manner which overcomes the difficulty of sealing gaskets against heated walls. A small dial thermometer built into the hot plate and viewed through the bell jar enables the energy regulator to be set for definite temperatures up to 160°C.

DEMONSTRATION.

Stand 101

THE RESEARCH LABORATORY, THE BRITISH THOMSON-HOUSTON CO. Ltd., Rugby

Optical Method for the Orientation of Silicon Iron Crystals. Plane-polarized light is used to illuminate at normal incidence the surface of the polished and etched polycrystalline specimen, which is supported horizontally. The etching reagent used is chosen to expose facets parallel to (100) planes of the lattice.

The specimen is viewed in a vertical direction through a polaroid sheet crossed with respect to the polarizer and is rotated continuously about a vertical axis. The grains are seen to fall into two classes, namely Class 1 grains which appear always of minimum intensity and which do not change their appearance during rotation. These grains are reflecting the light after a single reflection at normal incidence. Since the reflecting facets are known to be (100) planes these crystals have a (100) plane in the plane of polish. Class 2 grains are those exhibiting variations from maximum to minimum of intensity as the specimen is rotated. These grains are reflecting the light after either a double or a triple reflection at oblique incidence. They have no (100) plane near the plane of polish.

The method is of greatest use where a certain orientation is known to be preferred; then the section to be examined can be chosen so that (100) planes are expected and inspection shows whether this is indeed the case.

DEMONSTRATION.

A Mass Spectrometer Leak Detector†. Very small leaks in vacuum apparatus can be detected and located using a mass spectrometer as a vacuum gauge selectively responsive to one species of ions and thus to one gas only. Ions of mass 4 are produced only by helium; as this gas is not normally present in vacuum systems, a spectrometer set for mass 4 responds only when helium enters its vacuum system through a leak.

The instrument exhibited comprises a small mass spectrometer complete with vacuum pumps and electrical equipment, in a trolley cabinet, and has been designed to be suitable for use under industrial conditions. The spectrometer employs 180° magnetic focusing and is of the cold-cathode type, ensuring long life and eliminating the need for a refrigerated trap, A.C. mains and cooling water being the only supplies required. Leaks as small as 10^{-5} litre micron per second can be detected.

A Magnetic Field Strength Meter†. A Magnetic Field Strength Meter employing the Hall effect in germanium.

A small flake of germanium $\frac{1}{8}$ in. × $\frac{1}{16}$ in. × 0·015 in. thick is shown mounted in a probe, and thus is capable of exploring and measuring field strengths in very small gaps.

The range of the instrument is between 0 and 25,000 gauss, in three ranges, obtained from direct readings on a microammeter.

The Use of Compact Source Electric Discharge Lamps for Combined General Illumination and Condenser Flash Work†. Further researches concerning the possibilities of compact source lamps to give both general lighting and high intensity pulses has enabled the time duration of these pulses to be made so short as to include those obtained from condenser discharges. A Lamp will be demonstrated operating under these conditions and lamp developments enabling this work to be carried out will be explained. DEMONSTRATION.

Radiation Sources for Laboratory Work†. Often it is necessary to obtain powerful sources of radiation of definite wavelengths for studying the effectiveness of this radiation. Some of these conditions require a constancy of lamp output of a high order. The exhibit will show a number of experimental lamps suitable for this work as follows:

1. 250W Type ME/D Box Lamp fitted with a fused silica window.
2. 125W Type MB Stabilized Arc Lamp. (Bare fused silica arc tube.)
3. 125W (Type MB Stabilized Arc Lamp arc tube) with Xenon gas filling.
4. Special 400W Type MA arc tube operating at a low mercury vapour pressure to give the intense 4358 A. line with low background radiation.

DEMONSTRATION.

Oscillatory Conditions Produced by Electric Discharges in Mixtures of Mercury Vapour and Rare Gases Under Conditions of Cataphoresis. With prolonged operation passing direct current, mercury vapour from a rare gas–mercury vapour mixture will migrate towards the lamp cathode. As the discharge passes from the gas to the mercury, oscillations of various frequencies are produced. Some of these can be viewed stroboscopically and others detected photo-

electrically and shown by means of a cathode-ray oscilloscope. DEMONSTRATION.

A Portable Direct-reading Electrometer Valve Meter Suitable for Small Radiation Measurements. Developments of the 2537A. ultra-violet photo-electric cells and a portable measuring instrument enabling direct measurements to be made of intensities from one hundredth of a microwatt per cm^2 up to one hundred microwatts per cm^2 will be demonstrated. DEMONSTRATION.

B.T.H. Forrest Miniature Insulation Test Set†. A portable equipment, mains energized, for the measurement of insulation resistance between 10 and 60,000 megohms, at D.C. potentials of 1 kv. to 5 kv. The testing voltage is internally generated by a transformer and H.V. rectifier, and an indicator valve and self-contained adjustable resistance enables the external resistance to be measured.

The equipment is used for resistance testing of H.V. bushings, insulators and machine windings, and such tests at periodic intervals provide valuable evidence of gradual deterioration which may precede breakdown. The equipment is also suitable for testing oil samples from circuit breakers, etc.

Pulsactor — A Development in the use of Saturable Pulsactors as Discharge Devices for High Power Pulse Generators. The equipment exhibited illustrates one embodiment of the principles of Pulsactor Circuits, and is intended for use as a Radar Pulse Modulator.

From an input supply of 80 volts r.m.s. at 1500 c/s., rectangular pulses of 150 kilowatts peak power and 0·25 microsecond duration, are produced at about 13,000 volts and 12 amperes peak amplitude. This output pulse is used to modulate a 3 centimetre magnetron as a Radar Transmitter. Apart from the magnetron, no other electronic valves or discharge devices are used in the production of the high-frequency pulse.

The circuit consists of a quadruple cascade assembly of polarized Pulsactors associated with appropriate discharge capacitors arranged so that the discharge of the successive condensers is carried out at an increasingly rapid rate from stage to stage, culminating in the discharge of a capacitive pulse-forming network through a pulse transformer to generate the output pulse in the magnetron.

Pulsactor circuits are designed to take advantage of the extremely non-linear properties of recently developed magnetic materials such as H.C.R. metal — a 50/50 grain orientated nickel iron. The rapid change of permeability which occurs at the knee of the *B–H* curve of these materials, is utilized in such a manner that 'switching' actions such as are normally carried out by electronic discharge devices are achieved.

These circuits have several advantages, the principal among which are a high degree of stability of operation, and the elimination from the circuit of electronic valves and discharge devices of limited life. DEMONSTRATION.

Electrical Plotter†. Automatic plotting of functions of one independent variable requires a device capable of generating two coordinate motions which together represent both the variable and the function. A common arrangement is to have separate motions associated exclusively with each of the quantities, as, for example, of the pen and the paper of a recording meter. This system

produced an undesirable scale resulting from compounding one polar and one Cartesian motion, and a limited frequency response. It is to be expected that the function will require much more complex motions than for the variable (which usually performs a linear or sinusoidal sweep) and the more important parts of a curve may be affected by lags or overshoots in the pen or other position-following element.

The new Electrical Plotter uses electrical servos which have a response time of a few microseconds, and plots a curve up to 14 in. diameter on scales which are accurately linear in both directions. A metal stylus explores systematically the whole surface of a piece of electrical recording paper, and at any instant, the position of the stylus is represented by an 'X' voltage and a 'Y' voltage appearing at the terminals of the instrument. Whenever the function voltage generated in the circuit under test is in coincidence with the stylus 'Y' voltage, a mark about 0·010 in. diameter will be recorded on the paper. By avoiding any attempt at curve following with the stylus, all dependence on servo-responses is eliminated. The total time for tracing a line which extends from one side to the other of a 14 in. sheet should not exceed 2 minutes. Manual operation of the stylus position is also possible. DEMONSTRATION.

Pulsed Intermediate Frequency Signal Generator†. The fundamental objection to pulsing an intermediate-frequency oscillator is that in most practical cases the pulsing waveform itself produces a considerable output in the I.F. band. In order to obtain an undistorted and accurately known I.F. pulse, a pulsed V.H.F. oscillator is used and beats with another C.W. oscillator. The frequency of the latter oscillator can be varied in order to produce the desired I.F. signal. A crystal rectifier monitors the I.F. pulse shape and amplitude; a wavemeter monitors the frequency and a precision attenuator varies the output continuously over a range of 111 db. The cathode-ray tube which is included to display the output of the crystal rectifier, may also be used to display the output pulse from the second detector of the amplifier or circuit under test. When these two displayed pulses are brought into coincidence by adjustment of the attenuator in the signal generator, the gain of the amplifier under test and its pulse response are accurately known. Amplitudes of either polarity from 0·25 to 45 volts can be accepted by the cathode-ray tube comparison unit. The bandwidth of attenuator and mixer is 60 Mc/s.

Waveguide Test Equipment†. The basic range of waveguide equipment comprises, in each case, a Power Unit, Klystron Oscillator, Wavemeter, Padding Attenuator, Standing Wave Detector, and a Matched Termination. It is intended for precision measurements involving Standing Wave Ratio and Insertion Loss, at wavelengths of 3 cm. and 10 cm. of waveguide components utilizing, respectively, standard 0·900 in. × 0·400 in. and 2·840 in. × 1·340 in. waveguides.

The 3 cm. equipment uses a modulated power supply and a high-gain selective amplifier, the output meter of which is calibrated directly in standing-wave ratio.

Additional to the basic range, variable Attenuators, Short Circuit Termination Directive Coupler, Waveguide Adapters, Crystal Detector Mount, Thermistor Mount and Thermistor Bridge, all of which are for use in microwave measurements, are shown. DEMONSTRATION.

Stand 102

HALL TELEPHONE ACCESSORIES Ltd.

G.K.N. Group Services Ltd.
70, Dudden Hill Lane, Willesden, London, N.W.10

A Microhardness Tester for use with an Inverted Microscope†. The instrument provides a means of determining the hardness of a material at microscopically chosen points by making an impression with a Vickers type indenter with a small known load (up to 300 gm.). The hardness is deduced by measuring the size of the impression by means of the microscope.

A Microhardness Tester for use with a Bench Type Microscope†. The instrument, though different in design, carries out the same function as the instrument described above. It is however suitable for use with a bench type microscope. The load range is up to 100 gm.

A special type of stage, of high accuracy suitable for microhardness testing is shown with the instrument.

Stand 103

MARCONI'S WIRELESS TELEGRAPH COMPANY Ltd.,

Marconi House, Chelmsford

3 Centimetre Microwave Model demonstrating the land–sea recovery effect that has been predicted and observed on wavelengths of 4 m. and 100 m. and described in the *Proceedings of the Institution of Electrical Engineers.*

In this experiment, a metal sheet is used instead of sea to represent the medium of high conductivity, and it has been found that a good recovery of the field strength as under actual land–sea conditions can be obtained when the preliminary land is simulated by a metal sheet covered by a thin sheet of Paxolin.

DEMONSTRATION.

Wall Chart showing in pictorial and graphical form the daily and seasonal characteristics of the ionosphere in relation to short-wave communications.

Transmission of Telegraph Signals over Narrow Bandwidth. The equipment shown demonstrates the great economy in bandwidth afforded by the use of pulse amplitude modulation. Telegraph signals at the rate of 66 words per minute which conventionally occupy a bandwidth of 120 c/s. may be accurately conveyed by this means, over a bandwidth of 10 c/s.

At the transmitter, the output from a teleprinter is converted to pulses of discrete amplitude each of which corresponds to one character of the intelligence. The derived pulses may be used to modulate any type of radio transmitter and may be readily applied to multiplex systems. Thirty two levels are required to convey all combinations of the five unit code, which implies a noise level not less than 36 decibels below peak modulation.

The receiver applies the converse process and derives from each received pulse a group of pulses in the corresponding telegraph code which may then be used to operate the receiver teleprinter. DEMONSTRATION.

Stand 104

JOHNSON, MATTHEY & CO. Ltd.,
Hatton Garden, London, E.C.1

Platinum: Rhodium-Platinum Thermocouples†. Thermocouple wires and complete couples with welded hot junctions comprising Thermopure platinum with either 10 per cent or 13 per cent rhodium-platinum.

Resistance Wires†. Precision drawn fine resistance wires in nickel-chromium and copper-nickel in sizes down to 0·0005 inch diameter in either bare or insulated condition.

Minalpha Manganese-Nickel-Copper Alloy, developed to replace Manganin, having a temperature coefficient of $\pm$ 0·000003 from 10° to 40° and a thermal E.M.F. against copper of 0·3 μV/°C. (0 – 100°C.) This is obtainable in the form of precision drawn wire from 0·064 in. to 0·001 in. and sheet and strip in width from 6 in. to $\frac{3}{16}$ in., of thickness 0·050 in. to 0·002 in.

Silver-Palladium Resistance Wire†. Wire in a 40 per cent silver-palladium alloy, completely non-tarnishing, having a specific resistance of 42·0 $\mu\Omega$ per cm^3 and a temperature coefficient of resistance of 0·00008 per °C. (0 – 100°C.), for use in instrument-operated type potentiometers when low operating torque and low contact pressure are essential.

Electrical Contacts†. Headed, turned and composite contacts in silver, platinum, palladium and other alloys suitable for use in instruments where contact resistances must be kept to minimum values. Complete contact springs and sub-assemblies are supplied.

Beryllium-Copper†. Mallory 73 Beryllium-Copper alloy is shown in the form of strip and wire for electrical and instrument springs, and as Bourdon tubing for use in pressure gauges.

Wave-Guide Tubing†. Solid drawn high accuracy wave-guide tubing in copper, brass, 7½ per cent and 10 per cent copper-silver, and also in copper or brass lined with fine silver. Rectangular tubes are available up to 2 $\times$ 0·667 in., and are characterized by the sharpness of interior corners and the high quality of internal finish. Round tubes are also available.

Capillary Tubes†. Accurately drawn capillary tubes having bores from 0·10 in. down to 0·006 in. in copper or cupro-nickel. Clean-bored tubing with bore tolerances of $\pm$ 0·002 in. can be supplied in cut, flow-tested and sealed lengths.

Nickel Cathode Tubes†. Solid drawn high purity nickel cathode tubes either in drawn lengths or as cut, formed and beaded cathodes with diameters down to 0·010 in. and wall thicknesses down to 0·002 in. Rectangular and shaped tubes are also available with minimum dimensions corresponding to those for round tubes.

Silvered Mica Capacitor Plates†. Improved types of these plates have increased capacity per plate while still retaining the same dimensions and electrical characteristics of high stability, low power factor and substantial freedom from scintillation or noise effects.

Wax-Coated Precision Silvered Mica Capacitors†. Examples are shown of wax-coated precision silvered mica capacitors covering a range of capacity from 5 micro-microfarads to 0·25 microfarad, adjusted to a capacity tolerance of $\pm$ 0·5 per cent or 1 micro-microfarad, whichever is greater. High stability, lower power factor and cyclic performance with temperature are outstanding features.

Moulded Precision Silvered Mica Capacitors†. A robust moulded component of a new type gives a fully tropical performance, high capacity stability, a linear temperature coefficient of approximately 40×10^{-6} per degree C. and an insulation resistance of greater than 200,000 megohms over an ambient temperature range of $-$ 40°C. to $+$ 100° C.

Metallizing Preparations†. A range of metallizing preparations is available for the production of conducting films on glass, electrical porcelain and other ceramic bases.

Metallized Ceramic†. Metallized and 'tinned' ceramic are manufactured which are suitable for soldering to metal components. Standard low-loss lead-in bushes are suitable for radio and instrument apparatus at working voltages from 500 to 6,000.

Electrodeposited Rhodium†. Examples are shown of electrodeposited contact surfaces for use in instruments of all types where the electrical duty is light and where freedom from oxidation, tarnish and electrical noise is essential, as for instance in communication equipment. This material may be used as a protective finish against atmospheric attack and for use in the laboratory ; heat resisting optical reflecting surfaces can be obtained capable of maintaining their reflectivity in adverse conditions.

Low Temperature Brazing Alloys†. Specialized low temperature silver brazing materials are of value for instrument construction. Special fluxes are provided for use with these alloys.

Stand 105

BRYANS AEROQUIPMENT Ltd.,

Willow Lane, Mitcham, Surrey

Test Set for Temperature Indicators (Jet Engine). Specially designed for calibrating and testing millivoltmeter type pyrometer indicators, which work with copper-constantan, or chromel-alumel thermocouples.

The indicator covers four ranges :

1000°C. chromel-alumel thermocouples.
350°C. with copper-constantan thermocouples.
0–75 millivolts.
0–30 ohms D.C. resistance.

Dead Weight Pressure Gauge Tester†. Novel portable design which tests the following ranges :

10-500 lb/in^2 (1 lb/in^2 stages); 50-5000 lb/in^2 (10 lb/in^2 stages) (or metric equivalents).

Two interchangeable plunger-sleeve units allow for the complete range to be accommodated in one tester.

Stainless steel components enable the tester to be used with water.

Rate of Climb Tester†. The unique design enables automatic timing tests on rate of climb indicators.

The tester consists of a small mercury manometer with suspended contacts fitted in the tube, which control a synchronous timing clock through relays, the dial of which is segmented to indicate tolerances of rates of climb.

Leak Tester†. Specially designed for aircraft test *in situ*, to enable a leakage test to be applied to the static and pitot air lines.

An indicator showing leakage rate, a pump and a multi-way selector, are housed in a small portable metal case.

The hand pump and multi (10-way) selector enable the following tests to be applied to the air lines :

Pressure to the ' Pitot ' line.
Suction to the ' Static ' line.
Suction to ' Pitot ' and ' Static ' lines.
Release to atmosphere between each test point.

Gyro Test Table Mk. IV†. Modified design for testing all types of electrically driven gyro instruments in roll, pitch and yaw, and in azimuth rotation.

The table top is driven by an A.C. constant speed motor. A specially designed gear drive enables infinitely variable control of the speed over the range 0·3 r.p.m. to 8·0 r.p.m.

The table can be set to change rotation automatically every minute, the motor driving the table being controlled by a synchronous timing clock. The clock dial is graduated in seconds for timing and can also be set to time rates of turn automatically.

Gyro Test Table Mk. IIIA†. This new R.P.Y. table is similar in design to the Mk. IV, but accommodates the A.3 gyro pilot, and all types of air driven gyro instruments.

Automatic timing ensures extreme accuracy on rates of turn.

Pressure Vacuum Chambers (Portable)†. Two chambers are exhibited, the larger having a separate panel for controlling and distributing pressure-vacuum supply.

The small chamber is sealed by one quick release lever and has the control panel integral with the chamber.

Master Air Speed Calibrator†. New developments in manometric equipment enable air speed indicators and other types of low pressure gauges to be tested accurately under ideal operating conditions.

Special features :

A cursor with line sighting, to eliminate parallax error, which has fast and slow motion.

Floats with sighting discs clear of liquid.

A patented push-button selector to facilitate change-over from water to mercury.

Anti-spill liquid traps.

Quick release glands for dismantling and replacing tubes.

Accuracy is maintained by a very close tolerance on the cisterns, and the bore of the glass tubes.

Master Stroboscopic Desk†. The design enables all types of electrical indicators driven by generators and all types of mechanical indicators to be tested between the range 60 r.p.m. to 20,000 r.p.m.

The accuracy of the stroboscope is within 0·01%.

Thermometer Tester, Resistance Type†. Portable tester providing rapid and accurate tests on all types of aircraft resistance bulb thermometers, either of bridge or ratiometer varieties.

A decade resistance bank provides the ohmic comparison standard, which is converted to degrees centigrade when checking the indicators on test.

An input voltage of 210-230 volts 50 c/s. A.C. is converted to approximately 30 volts D.C., which is adjusted by coarse and fine rheostats.

Stand 106

ASSOCIATED ILIFFE PRESS,

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Technical and Reference Books† :

Television Receiving Equipment. W. T. Cocking, M.I.E.E.

Wireless Direction Finding. R. Keen, M.B.E., B.Eng.

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The Modern Diesel. Edited by G. Geoffrey Smith, M.B.E. Revised and rewritten by D. H. Smith, M.I.Mech.E., Assoc.Inst.T.

Radio Laboratory Handbook. M. G. Scroggie, B.Sc., M.I.E.E.

Dictionary of Photography. A. L. M. Sowerby, B.A., M.Sc., A.R.P.S.

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Electrons, Atoms, Metals and Alloys. W. Hume-Rothery, M.A., D.Sc., F.R.S.

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Radio Data Charts. R. T. Beatty, M.A., B.E., D.Sc., revised by J. Mc.G. Sowerby, B.A., A.M.I.E.E.

Resistance Welding in Mass Production. A. J. Hipperson, B.Sc. and T. Watson.

Short Wave Radio and the Ionosphere. T. W. Berrington, Engineering Division of the British Broadcasting Corporation.

Welding Dictionary: French, German, Spanish and English. R. N. Thompson and G. Haim.

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Theoretical Hydrodynamics by Prof. L. M. Milne-Thomson†. This book aims at giving a thorough, clear and methodical introductory exposition of the mathematical theory of fluid motion which will be useful in applications to both hydrodynamics and aerodynamics. In the recent second and revised edition there is a new chapter on Compressible Flow.

Theoretical Aerodynamics by Prof. L. M. Milne-Thomson†. A course based on lectures given at the Royal Naval College, Greenwich, and assuming only a knowledge of the elements of differential and integral calculus. The book should provide a solid introduction to the theory for university students starting a course on aeronautics.

Elements of Aerodynamics of Supersonic Flows by Antonio Ferri†. Written by a leading authority in America on gas dynamics and compressibility, this book presents, from an aeronautical point of view, the theoretical foundations of two-and three-dimensional flow, with special reference to wing design and instruments in high-speed flow and other related topics.

A Textbook of Practical Physics by Prof. H. S. Allen, F.R.S., and Prof. H. Moore†. This well-known book covers most of the work in practical physics necessary for a general degree in science. There are many experiments in practical mechanics, and in the third edition the new material covers high-frequency oscillations and thermionic valves.

Intermediate Practical Physics by T. M. Yarwood†. In the second edition this book has been extended by some thirty experiments ; it deals with practical aspects of physics needed for Higher School Certificate and similar examinations, with essential theoretical notes.

A Textbook on General Physics by G. R. Noakes. Mr. Noakes' books on Heat, Light and Electricity and Magnetism have become standard textbooks of Intermediate examination standard. He has now rounded off a complete course of physics by a book, written in his usual meticulous manner, on the general properties of matter, including the appropriate work on Sound. (In the press).

A Textbook of Heat: For Upper Classmen by Dr. L. D. Weld.† A new and up-to-date textbook on heat and thermodynamics for first and second year honours students. The subject matter is presented in a smooth continuous sequence, certain topics (such as thermometry and thermodynamics) being dis-

tributed at appropriate intervals throughout the book, instead of being in separate chapters.

Principles of Electricity by Prof. L. Page and Prof. N. I. Adams, Jr.†. The new second edition has been brought thoroughly up to date and is suitable as a general text in electricity and magnetism for honours physics students. The new topics include discussion of the cyclotron, betatron and waveguides.

Ultra and Extreme Short Wave Reception by Dr. M. J. O. Strutt†. Within the frequency range of 6-30,000 Mc/s., the author considers wave theory, noise, antennae, waveguides and resonant cavities, instruments, amplifier and mixer stages, and general over-all design of receivers. Mathematics have been cut to a minimum, reasoning being substituted in many cases for elaborate formulae.

Electron and Nuclear Physics by Prof. J. Barton Hoag and Prof. S. A. Korff†. In the third edition of this book Prof. Korff has incorporated much new material on the new accelerating devices, neutron experiments and the structure of the nucleus, and cosmic rays. The book is, on the whole, of a practical and descriptive nature and should appeal to those starting a specialized university course in physics.

High Vacua by Dr. Swami Jnanananda†. The main part of this work deals with different types and varieties of vacuum pumps used for the production of the very high vacua that are needed in modern physics. Also included are chapters on the theory of gases, measuring instruments and the use of absorbent materials.

Elements of Acoustical Engineering by Dr. Harry F. Olson†. A book with an essentially modern approach to acoustics, particularly with regard to the emphasis on electrical apparatus and also the development of analogies between electrical, mechanical and acoustical systems.

Powder Metallurgy : Its Physics and Production by Dr. Paul Schwarzkopf†. The author of this work is a pioneer and leading authority in this subject, and being tied by no commercial restrictions, has here set down his full store of accumulated knowledge. The four main sections deal with processing, properties of products, theoretical principles and future developments.

Applied Mathematics for Engineers and Scientists by S. A. Schelkunoff†. This book amply fulfils its title. Divided into two parts, the first deals with general mathematical methods up to differential equations of the first order. The second more advanced part is concerned with special transcendental functions such as gamma functions, Fresnel integrals, Bessel functions and Legendre functions.

Science and its Background by Dr. H. D. Anthony†. An outline survey of the history of scientific discovery in its relation to contemporary events, based mainly on selected biographies. A readable book for the student and layman.

Voyages to the Moon by Prof. L. Marjorie H. Nicolson†. Professor Nicolson has collected together a wealth of material of the literature (up to the end of the eighteenth century) dealing with cosmic voyages and man's imaginative speculations on outer space.

Stand 112

SIR ISAAC PITMAN & SONS Ltd.,

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Among our many technical publications for 1949/50, there are three of outstanding merit that should be noted.

The Principles of Television Reception by *A. W. Keen* (due February, 1950, about 25*s*. net) is something new in television literature. It describes the underlying principles of the subject rather than merely examining its general field of application. It is in four parts ; the first gives an outline of the complete television process, the second, a stage-by-stage examination of the receiver, the third describes the aerial system, and the fourth reviews the problem of transmission in colour. In this comprehensive study, both British and American techniques are equally considered.

Radio Frequency Heating Equipment by *L. L. Langton* (published 27th September, 1949, 17*s*. 6*d*. net) deals with a branch of electrical science now finding considerable application in industry, and is an important contribution to the limited literature on this subject of heating by electrical waves. It gives a thorough treatment of the design of oscillating systems for the generation and transfer of radio-frequency power, and provides a detailed survey of the theory of equipment construction.

Electrical Technology by *H. Cotton* (published 4th October, 1949, 18*s*. net) is a new edition of a famous work, long recognized as the standard textbook for many examinations, and an established book of reference for electrical engineers. As well as being revised and brought up-to-date, much new material is included covering general circuit theory and illumination.

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UNITED TRADE PRESS Ltd.,

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Instrument Practice†. A monthly journal covering the whole field of instrument technology and instrumentation. Annual subscription 30*s*.

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Principles of Scientific Research† — *Paul Freedman*, B.Sc., M.I.E.E., F.I.E.S.
With thirty years of experience of scientific research behind him, the author has presented not only a picture of the equipment and method used but also relates scientific research to its social and intellectual environment. This book has had an enthusiastic reception from the Press, both technical and general.

Electrical Measurements and the Calculation of Errors Involved† — *D. Karo*, Dip. Eng. E.S.E., Dip. Eng., University of Caen, A.M.I.E.E.
An important book on direct current measurements for students and laboratory workers, covering the syllabus for Part II B.Sc. (Eng.) of the University of London.

Design of Direct Current Machines† — *L. Greenwood*, M.I.E.E., M. Amer. I.E.E., M.I.Mech.E.
A practical book with worked designs, including a great deal of data for students and draughtsmen.

Overhead Line Practice† — *John McCombe*, Ph.D., A.R.T.C., M.I.E.E.
An up-to-date guide on modern overhead line practice intended for use by all concerned with the layout, design and erection of power lines.

Elementary Engineering Design† — *H. A. Morgan.*
Intended to help student draughtsmen to apply their knowledge to simple design problems. A number of worked designs and exercises are included.

In Preparation.

Electro-Magnetic Machines — *R. Langlois-Berthelot.*

Theory and Design of Inductance Coils — *V. G. Welsby.*

Elementary Mathematics — *L. W. Phillips.*

Factory Electrification — *C. H. Pike and F. T. Bartho.*

Engineering Metrology — *K. J. Hume.*

Worked Examples in Illuminating Engineering — *J. R. Harris and R. W. Ames.*

Strength and Elasticity of Materials — *W. H. Brooks.*
(Theory of Structures); worked answers to B.Sc. examination questions.

Electroencephalography — Ed. by *Dr. Denis Hill and Geoffrey Parr*, M.I.E.E. Foreword by *Prof. E. D. Adrian*, O.M.

This is the first comprehensive textbook on the subject to be published. It is a symposium on the science of recording and interpreting the electrical activity of the brain. The sections are written by experts in physics, physiology, biochemistry, pharmacology, or clinical medicine; and the book embodies their collective experience in the technique of recording and in the interpretation of results. This will be published very shortly.

Stand 115

METROPOLITAN-VICKERS ELECTRICAL CO., Ltd., Trafford Park, Manchester, 17

'Metroflux' Simplified Permeameter† (Figure 1). This permeameter can be used for the routine testing of magnet steels for remanence, coercivity, maximum energy and recoil data. It can be used also for tests on ferrous meterials of low and medium permeability for values of magnetizing force $H = 5$ to 1,500.

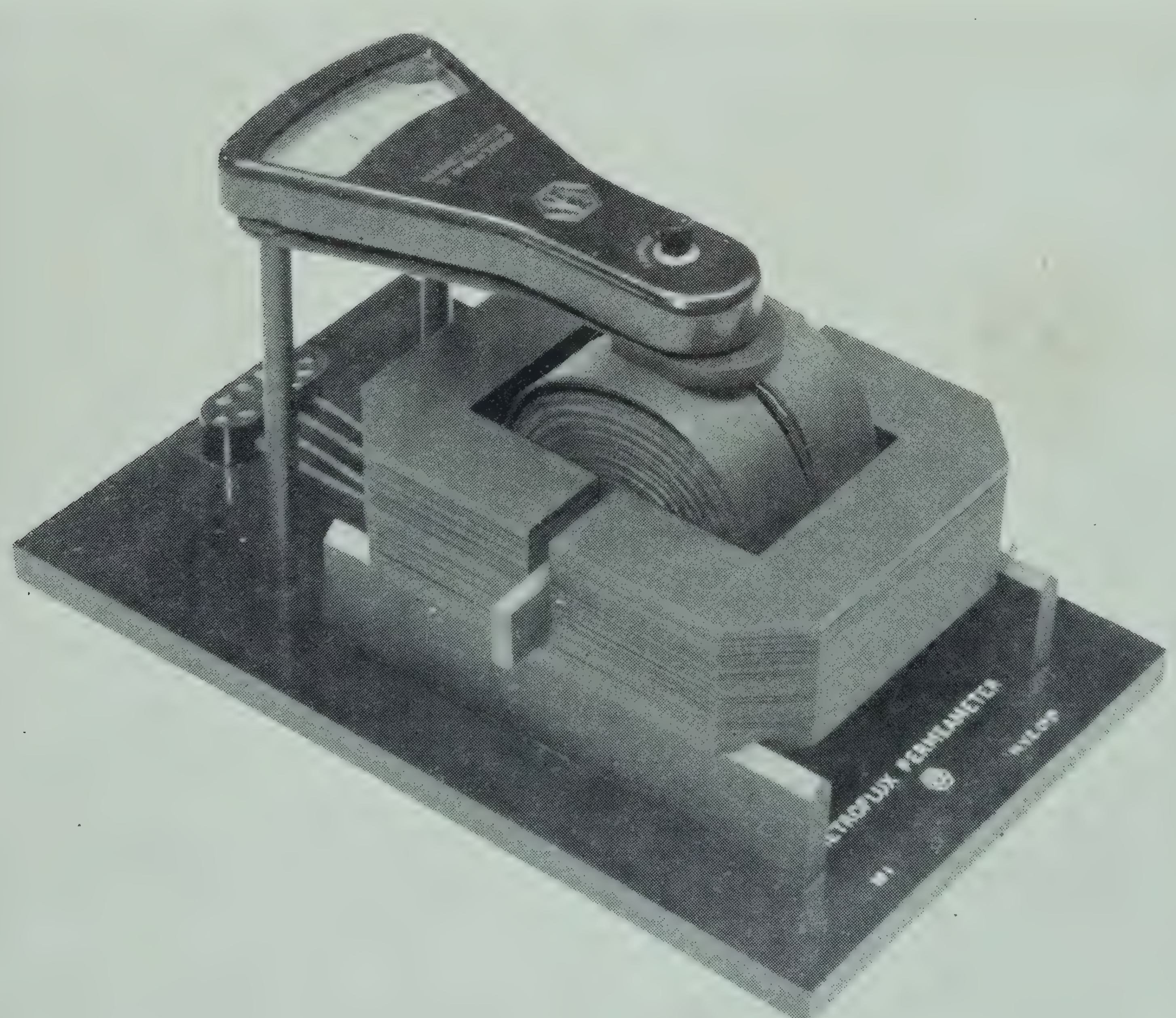

Figure 1. Simplified permeameter for magnet steels.

By measuring the changes of flux in the test piece by means of a special fluxmeter of the Grassot type, and the magnetizing force by means of a 'Metroflux' magnetometer of appropriate range, steady readings on both instruments are obtained during observations, and results can be worked out quickly.

Specimens up to ½ in. × 1 in. cross section and upwards of 5 in. in length can be tested. Normal (B, H) curves, hysteresis loops, and recoil curves can be determined.

The control of the magnetizing current necessary to give the required sequence of excitation is by means of a special current reversing and reducing switch panel, supplied from a secondary battery through graded rheostats. A multi-range ammeter is provided to indicate the current. A maximum current of 20 amp. at 20 v. is required.

'Metroflux' Permanent Magnet Permeameter†. This permeameter is a development of the 'Metroflux' simplified Permeameter described above. It has similar applications but the flux for excitation of the test piece is provided by a variable permanent magnet fitted with D-shaped soft iron pole pieces. This magnet can be turned on its axis in a tunnel gap in a soft iron yoke which has extension arms applying the flux to the test piece. This arrangement replaces the usual magnetizing supply, coil, ammeter, rheostats and reversing and reducing switches.

'Metroflux' Moving-Coil Magnetometer†. This instrument is similar in all details to the moving magnet probe magnetometer except that the moving magnet is replaced by a moving coil, the dimensions of which are 0·050 in. × 0·025 in. × 0·125 in. long.

The moving coil is inserted into the lower end of a pivoted shaft enclosed in the exploring probe and is connected to the terminals on the rear of the instrument case via two hair springs. The instrument has a centre-zero scale reading 15,000—0—15,000 oersteds, and the range can be doubled by halving the current flowing through the coil. The appropriate coil current is obtained from a dry cell through a rheostat; the probe is inserted into the field of a standard permanent magnet accompanying the instrument and the current adjusted so that the magnetometer indicates the corresponding value.

The probe will enter a gap of 0·090 in. with its protective cover removed. The axis of the moving coil is inserted at right angles to the measured field, giving a left-hand or right-hand reading on the centre-zero scale, and thus indicating polarity. DEMONSTRATION.

Electrostatic Clutch†. A polished disc of high resistance semiconductor and a polished metal disc, both optically flat to 10^{-4}cm., are pressed lightly together. When a potential is applied between them, a force of attraction is developed approximately proportional to the square of the potential across the discs.

The model shown is a commercial prototype with discs 2 cm. diameter. With one member stationary and the other running at 1,000 r.p.m., the clutch will pick up against a torque in the region of 2,000 — 3,000 gm.cm. with a voltage of 500 applied between the steel and the semiconductor. A torque of 4,000 – 6,000 gm.cm. is required to produce slipping when the clutch is energized at the same voltage. The current taken is a few microamps. DEMONSTRATION.

Continuously Evacuated Cathode-ray Oscillograph†. This instrument is used for the observation and recording of the wave-shape and duration of the surges produced by an impulse generator. It is of the electrostatically-deflected continuously-evacuated demountable type, this construction enabling the electron beam to fall directly on the photographic emulsion.

The tube itself stands vertically on the operating desk and has a hot cathode gun which is supplied with up to 100 kv. D.C. through an H.T. cable from the D.C. set in a separate cubicle. After acceleration to the anode, the beam is focused magnetically by a solenoid and then passes through the deflection chamber. Each of the two pairs of plates has a sensitivity of about 1 kv. full scale. The impulse voltage is taken from the generator by a delay cable connected to a potential divider, and the time-sweep voltage from an electronic circuit in the desk of the oscillograph.

The recording chamber enables the trace to be viewed directly on a fluorescent screen which has sufficient after-glow to make the trace visible for a few seconds after the sweep of the beam. For photographic recording the screen is lifted to allow the beam to fall directly on the photographic film. To reload the camera the vacuum in the whole tube is released and the new film is inserted, after which the tube is re-evacuated. If the film has been pre-dried, the operation can be completed in fifteen minutes.

The vacuum is produced by a Metrovac Type 03B oil diffusion pump backed by a Type DR1 rotary pump which is mounted separately from the main units. Damage to the electron gun is prevented by the interlocking of the H.T. supply with both the air leak valve for admitting air into the oscillograph tube and a Pirani vacuum gauge.

The D.C. power unit contains an oil-immersed 100-kv. D.C. set fed from a high-frequency oscillator, the output being stabilized to 1 part in 25,000 over short periods by a feedback amplifier. The D.C. supply for the focusing solenoid is stabilized to within 0·01%. DEMONSTRATION.

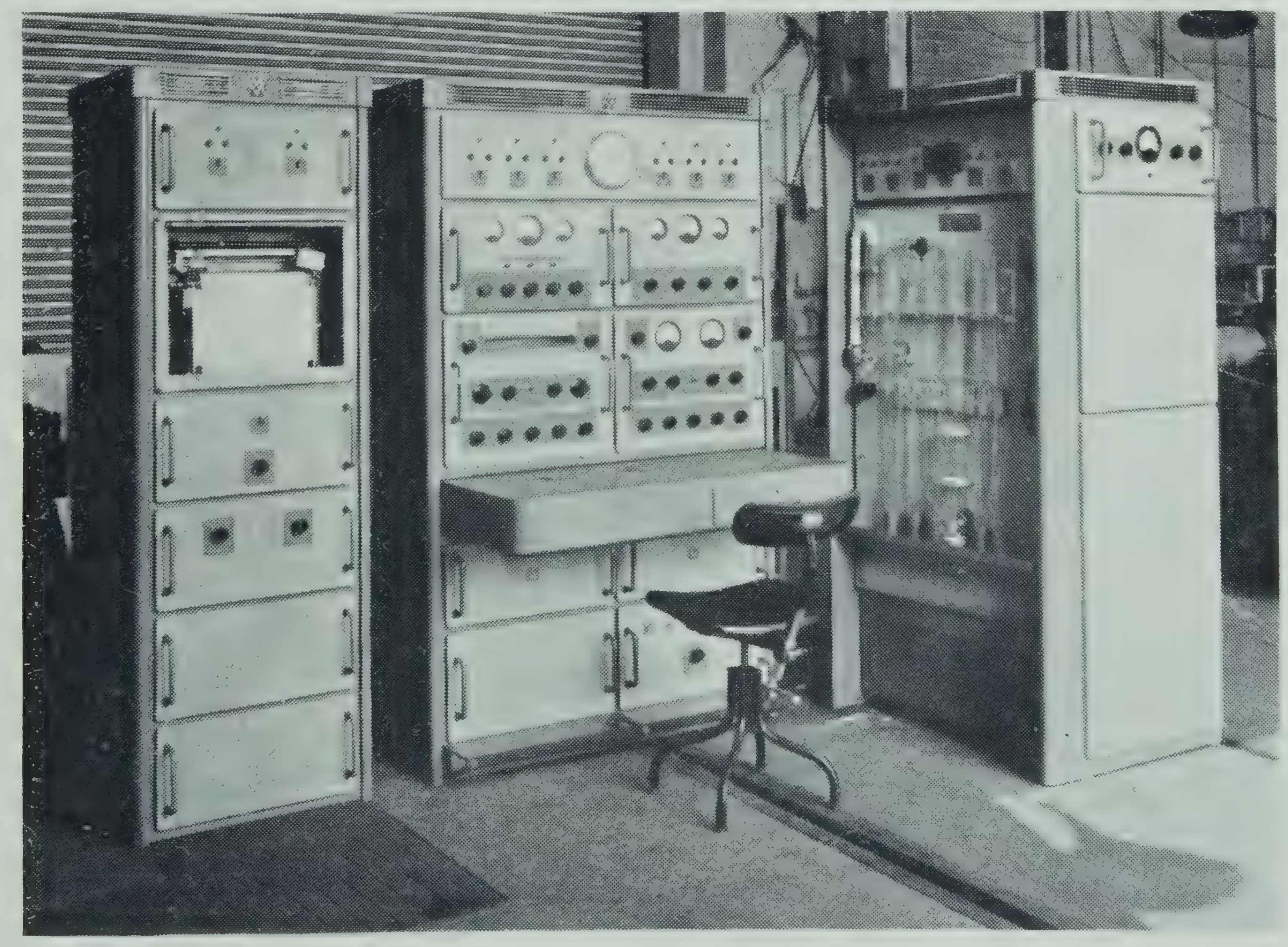

Figure 2. Mass spectrometer complete.

General Purpose Mass Spectrometer† (Figure 2). This model is the commercial version of the experimental instrument exhibited in 1948. It is intended for measurements on ions having m/e ratios between 1 and 250.

Any of the more common types of problem encountered in mass spectrometry, e.g., isotope assays, studies of ionization and dissociation, analysis of hydrocarbon mixtures, can be undertaken without modifying the instrument, while the construction permits less common problems, such as gas reactions and the formation of intermediate products in combustion, to be studied with a minimum of instrument change.

For convenience in manufacture, installation and operation, the instrument has been arranged in three distinct units. The first contains the spectrometer tube, magnet, vacuum system and gas-handling plant ; the second houses all the electronic stabilizers, power supplies and the controls necessary for manual operation ; the third unit is an automatic sweep control and abundance recorder. The latter unit is of vital importance in studying complex spectra such as those resulting from the cracking of hydrocarbon molecules and is also proving of great benefit in the measurement of isotope abundance ratios.

A completely demountable, all-metal, 90° sector-type tube is used, which is built and aligned in accurate jigs such that the ion source or the collector can be removed and replaced, when necessary, in precisely the same position simply by breaking conventional gasket seals. The tube is fully protected against failures of power or water or unexpected vacuum leaks.

Measurements of abundance to an accuracy within $\pm$ 0·5% are already obtainable for all isotopes present to the extent of 1% or more of the most abundant isotopes, i.e., samples of abundance ratios 100·0 and 99·5 can be distinguished. Greater accuracy is largely dependent on the patience and skill of the operator.

Beams may be selected one at a time by variation of either the ion-accelerating voltage or the magnetic field, and measured either by a direct-reading feedback amplifier or by the more conventional manual feedback method. Alternatively, two beams may be collected simultaneously and compared by a potentiometric method. Gauges for monitoring the sample pressure, and a continuously reading fluxmeter which indicates the m/e ratio of the particular ion being measured, are also included in this unit.

Any single peak or any desired portion of the spectrum can be recorded on a 10 in. chart at the rate of about 1 mass number in 15 seconds. Automatic speed-up of the paper drive occurs between peaks, and in addition, manual speed-up can be used when a particularly wide gap occurs in the spectrum being recorded. Automatic range changing enables a wide range of abundance values to be recorded with an absolute error, after correction from calibration, of $\pm$ 0·1% F.S.D. Any of these automatic devices can be switched out of circuit when not required.

The general layout permits flexibility of application with simplicity of operation and servicing, the electronic chassis all being mounted on pull-out drawers.

DEMONSTRATION.

Differential Methods of Vacuum Leak Detection. The apparatus exhibited is set up to demonstrate two methods of vacuum leak detection which have been the subject of development, namely :

(*a*) A differential method based on absorption of carbon dioxide by calcium hydroxide, the detector of a change in gas composition being the Pirani gauge.

(*b*) A differential method based on condensation of butane, employing liquid air and ionization gauges.

Method (*a*) is most suitable, with the detector placed on the backing side of the diffusion pump, for routine test work and for general laboratory work when leaks, at rates down to a value of 10^{-3} lusecs, are to be located. Method (*b*) may be used, under favourable circumstances, for leaks 100 times smaller than this.

DEMONSTRATION.

Waveguide Attenuators†. A satisfactory attenuating component for waveguides consists of a thin metallic film formed by vacuum deposition on appropriately shaped polished glass plates. The thickness of the film, which determines the D.C. and U.H.F. resistance, can be controlled within narrow limits during deposition. An alloy of nickel and chromium is a good material for this purpose since it has a low temperature coefficient of resistance (of the order of 3×10^{-5} per degree Centigrade in film form) and under suitable forming conditions adheres strongly to the glass surface as a hard coating. As protection against chemical attack under adverse atmospheric conditions which might ultimately change the attenuation characteristic, the metallic film is covered with a thin hard coating of magnesium fluoride. The surface of the attenuator vane can be made extremely resistant to abrasion.

Vanes for mounting as either fixed or variable attenuators for the 3-cm. band are exhibited. Typical vanes consist of flat strips of hard borosilicate glass having suitably tapered ends. This type is mounted on cam or screw operated sliding supports permitting the vane to be moved across the waveguide to give continuously variable attenuation. The movement is coupled to a dial calibrated in decibels.

Dilation-Temperature Recorder. The apparatus is essentially an (X, Y) plotter, specially developed for use, together with a dilatometer, in making automatic records of thermal expansion effects in metal or other specimens.

The recorder is adapted from a standard Multilec temperature recorder (by George Kent Ltd., Luton) which is operated by a thermocouple and moves a pen across a chart on a plane table in accordance with the temperature to be recorded. A second measuring unit, operated by a conventional dilatometer embodying the remote-reading dial micrometer previously exhibited at the Thirty First Exhibition of the Physical Society, 1947, and described in the *J. Sci. Instrum.*, Vol. 25, No. 8, August 1948, causes the table to traverse in accordance with the length change of the specimen. The direction of motion is at right angles to the line of movement of the pen, which thus traces the dilation-temperature record for the specimen under test.

The original time-base chart mechanism of the Multilec recorder is retained, so that a temperature–time record is also provided. Alternatively, by the mechanical coupling provided, the dilation may be recorded against time, enabling the instrument to be used for purposes such as the study of length changes at constant temperature, for which the dilation–temperature and temperature–time records do not provide the necessary information. DEMONSTRATION.

Analogy Model for the Solution of Unsteady-State Heat Conduction Problems. This model has been developed primarily for solving heat conduction problems associated with the heat treatment of metals, of which the specific heat and thermal conductivity may vary widely over the temperature range involved. Since these factors are automatically allowed for, this model constitutes under

such conditions an alternative to those models based on the familiar electrical resistance–capacity analogy.

As with the electrical analogy, the present arrangement involves a 'lumping' procedure. The flow of heat through a given lump is represented by the laminar flow of air through a small capillary, the analogue of temperature being pressure above a suitable datum. The heat content of the lump at a given temperature is represented by the mass of air contained in a reservoir at the corresponding pressure. The reservoir forms one limb of a U-tube, the air being confined above a suitable liquid, the level of which varies with the pressure of the air above it.

Subject to certain practical limitations any desired specific heat–temperature relation for the conducting medium, including latent heat effects, can be simulated by varying appropriately the cross section of the U-tube limb along its length. The case of variable thermal conductivity can also be treated by means of a simple preliminary substitution in the heat conduction equation. DEMONSTRATION.

Automatic Blood Corpuscle Counting Apparatus. The exhibit comprises apparatus for counting the red corpuscles in human blood, the count being made automatically by electronic means. The blood, diluted to an accurately known extent, is passed down a fine capillary, an image of which is directed on to a photo-cell. The passage of each corpuscle produces an electrical impulse and the impulses are counted by electronic scaling units, the total count being indicated on a mechanical register. DEMONSTRATION.

High-Speed Recurrent Waveform Monitor. (A system of exhibiting on a cathode-ray tube a recurrent waveform having frequency components as high as 250 Mc/s. and, if necessary, of less than 1 volt amplitude.) The method used in the equipment is to convert a recurrent waveform having high frequency components into a waveform of the same shape, but of lower recurrence and having very much lower frequency components; e.g., a radar transmitter output consisting of a microsecond pulse of 200 Mc/s. oscillation and 2,000 p.p.s. recurrence may be converted into a waveform of 20 p.p.s. recurrence consisting of a 50 millisecond pulse of 4,000 c/s. oscillation. The amplification and presentation of the converted waveform on a cathode-ray tube is a simple matter.

The actual conversion of the waveform being monitored into an identical waveform at lower frequency is carried out in a single small valve which is placed in very close proximity to the circuit being monitored. The low frequency waveform output from this valve is fed into the main equipment by means of cables. The high frequency waveform is fed into the frequency converting valve by means of a capacity divider which is chosen of such a value as to give about 1 volt amplitude input to the frequency converting valve. Waveforms of greater than 20 volts amplitude are loaded by less than 1 pF. capacity when being monitored.

The advantages of the system are immediately apparent:

1. The waveform being monitored suffers no distortion due to cathode-ray tube plate capacity or the ringing of monitoring leads.
2. Waveforms of low amplitude may be amplified quite satisfactorily, which is not possible using standard methods of monitoring at the frequencies being considered.
3. There is no interaction between the plates of the cathode-ray tube, and a

double beam cathode-ray tube may be fed, enabling two concurrent fast waveforms to be viewed simultaneously.

4. There is no loss in brightness of display and no difficulty in providing a flyback blanking pulse, as are normally encountered when using standard methods of high-speed monitoring.

The means by which the time scale conversion of the waveform is carried out are as follows :

During one recurrence of the waveform being monitored the instantaneous amplitude of the beginning of the waveform is measured and a voltage level is obtained which is proportional to this instantaneous amplitude. This voltage level is maintained constant until the next recurrence of the waveform when the instantaneous amplitude is again measured, but at a point slightly later than during the previous recurrence. After a large number of recurrences the whole of the waveform has been covered, and an identical waveform at low frequency has been traced out and applied to the Y plate of a cathode-ray tube whose X plates have been fed with a waveform proportional to the movement of the instantaneous measurements of waveform amplitude along the length of the waveform.

The equipment on view has a built-in calibrator to enable time scale measurements to be made, and a means of measuring the amplitude of the waveform being monitored.

Applications have been made for the necessary patents.

'Metrovac' Type S.R.3 Rotary Vacuum Pump†. The Type S.R.3 is a single-stage oil-sealed rotary vacuum pump of similar construction to the Type S.R.5, that is, of the twin-vane eccentric-rotor type. The pump can be supplied either separately or motor-driven by a ¾ H.P. motor through a twin V-belt drive, with belt-guard and bedplate. The pump castings are manufactured from special close-grained cast-iron, which is vacuum tested, and ball and rubber bearings are used for location and mounting of the rotor. Speed of rotation is 600 r.p.m., displacement 6½ litres per sec., pumping speed 5½ litres per sec., and the ultimate pressure obtainable 10/20 microns, measured by Pirani gauge in a normal practical system.

'Metrovac' Type 043C Oil Diffusion Pump†. The Type 043C oil diffusion pump fills the gap in the 'Metrovac' series between the Types C3B and 063B. The pump, which is similar in appearance to the 063B and 083B, is a water-cooled three-stage type, and uses Apiezon 'G' or 'B' oil as the operating fluid. Redesign of the jet system has resulted in a large comparative increase in pumping speed, especially at lower pressures, and an increased backing pressure. The pumping speed is now at least 250 litres per sec. below a pressure of 10^{-4} mm.Hg and the maximum backing pressure for optimum operation is 0·2 mm.Hg at a fore-pressure of 3×10^{-4} mm.Hg. These performance figures were obtained with the standard 6 in. diameter water-cooled baffle on the pump inlet.

Electron Microscope — Type EM4. The Type EM4 electron microscope has been developed as the topical complement to the Types EM2 and EM3 shown in past years.

Resolution obtainable with this new instrument is 100 Ångström units, which

is comparable with that for the Type EM3 (50 Ångström units), but manufacture has been simplified at the cost of some of the facilities incorporated in the latter.

A console type of desk contains all the equipment and hinged panels are arranged to open and give easy access to all parts. Connections to external supplies comprise a run of cab-tyre cable to a 50 c/s. single-phase supply capable of providing about 1½ kw. at 200/250 volts and rubber hose for water inlet and drain from a source to supply about ½ gallon per minute at an inlet pressure of 10 lb/in^2.

The Type EM4 has a multiple lens image-forming system, which provides a magnification range covering approximately 1,000× to 20,000× by lens current control and which permits a compact design of stack, which, in this instrument, is horizontal and housed in the top of the desk.

Magnetic lens design generally follows Type EM3 practice but a shorter stack and increased stage magnification has been obtained by the development of a new single-unit compound projector lens. Lens windings are outside the vacuum.

A specimen airlock is used which reduces pumping time to ½ minute after change of specimens. The specimen holder takes three standard 3-mm. diameter grids and the mechanical stage has adequate movement to cover all parts of these. Provision is made for stereo-micrography.

The camera is designed for 70-mm. film and a single loading gives not less than 15 exposures. Pumping down time after reloading the camera is 10 minutes, which includes for normal degassing of film.

The electron source is a self-biased hot-cathode gun integral with the condenser lens. The high voltage supply is fixed at 50 kv. and is obtained from an air-insulated H.F. D.C. set contained in a screened compartment forming part of the desk. Circuits for electronic stabilization of the H.T. and lens currents to the required tolerances are located on a chassis in the top of the desk.

In general the design aim has been to simplify manufacture and reduce controls to a minimum, to maintain a high performance comparable with the Type EM3 and to produce a small, self-contained instrument suitable for routine work.

DEMONSTRATION.

NEWTON VICTOR Ltd.,

15, Cavendish Place, London, W.1

Rotating Anode X-ray Diffraction Unit†. A new model of the Raymax Unit is shown fitted with a rotating anode tube with the rating increased to 100 ma. at 50 kv. peak on a copper target with a focal spot 10 mm. × 1 mm. The well-proven and successful characteristics of the standard Raymax diffraction unit are retained but modifications to the design have been made where necessary to permit the use of higher currents. The rotating anode is in the form of a truncated cone with a half-angle of 6° mounted on a horizontal shaft so that two beams of radiation are provided, one normal to the side of the tube housing and the other at an angle of 12°. This arrangement facilitates the use of large and complicated cameras on one side of the tube while the other beam of radiation can still be used for the smaller and more conventional cameras.

The rotating seal consists of two opposed 'Gaco' rubber seals with the intervening space filled with Apiezon 'J' Oil. This type of seal has been the subject of very protracted tests and has proved very efficient and completely free from leakage.

The anode is rotated at approximately 1,000 r.p.m. by a small motor mounted above the tube. All high vacuum joints on this tube are made with rubber gaskets so that the replacement of filaments, windows, etc., is extremely simple. The body of the tube as well as the hollow anode are efficiently cooled by a continuous flow of water. The x-ray tube is evacuated by a type 03B oil diffraction pump through a pipe of adequate diameter thus ensuring a high vacuum and stable operation. The width of the tube head is only slightly greater than that of the normal stationary anode tube so that short camera to focal spot distances permit full advantage to be taken of the increased output of x-radiation.

The rotating anode tube is mounted on the Raymax Unit in the same position as the stationary anode tube and the two beams of radiation are at the usual height above the platform. The windows of the tube are aluminium foiled 0·001 in. thick and are easily replaceable, the joint being made by a rubber gasket.

The kilovoltage is continuously adjustable between zero and 100 kv. so that the tube can be efficiently outgassed and operated at voltages above 50 kv. with appropriately lower currents if required.

The overall dimensions of this new model of the Raymax have not been changed but a supply of 60 amp. at 230 volts is required to operate the tube at this maximum rating.

Stand 116

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH,
Dorland House, 14-16, Regent Street, London, S.W.1

BUILDING RESEARCH STATION,
Bucknall's Lane, Garston, Watford, Herts

Circuit Multiplier and Integrator applied to Multipoint Recorder. In the large scale experiments on heating at present being carried out by the Building Research Station, it is necessary to record temperatures at a large number of points. Resistance thermometers are used for the temperature measurements in conjunction with 12-point self-balancing bridge type recorders.

With these recorders readings are taken of each point at six minute intervals. For most purposes less frequent recordings of a larger number of points is more satisfactory. To achieve this, relay circuits have been devised which automatically transfer the recorder connections from one group of 12 temperature measuring points to another. The transfer can be repeated as often as desired and the number of measuring points increased in multiples of twelve. In the model shown the multiplier increases the number of recorded points from 12 to 48 with corresponding increase in the time for repeat readings of each point from 6 to 24 minutes.

For many applications the average temperature over a period of, say, one week is more important than the temperatures at particular times. To obtain these averages manually from the records is tedious, and an automatic integrator has been made which converts the temperature readings as they are obtained into a

series of electrical impulses. These impulses are fed into a P.O. type counter, there being one counter for each of the temperature points under investigation. To obtain the mean weekly temperatures, the counters need only be read weekly, and the differences in the readings divided by the number of observations made. A clock control is used to provide that 100 readings are fed into the integrators per week for each point and so the operation of calculating the weekly mean is reduced to finding differences and moving the decimal point.

The whole apparatus consisting of recorder, circuit multiplier and integrator will be shown in operation together with illustrations of some of its applications.

DEMONSTRATION.

CHEMICAL RESEARCH LABORATORY,
Teddington, Middlesex

Molecular Models. Molecular models of the 'ball and spoke' variety are readily available in this country, but for certain physico-organic problems, models of the alternative Stuart pattern present some advantages. There are, however, considerable difficulties in the economic fabrication of such models and their development has therefore been slow.

An attempt has now been made to devise methods of fabrication for prototype sets and, having decided on a satisfactory specification, to explore the possibilities of larger scale production. In this way it is hoped to provide a source of supply within the reach of the average laboratory.

Specimen molecules, individual atoms and some jigs used in prototype fabrication are displayed. Attention is particularly directed to the coupling which is simple, hard-wearing and satisfactory in operation. Moreover, such wear as does occur is localized on the inexpensive bond.

The physical dimensions of the individual atoms are believed to represent a fair approximation to average observed values.

Mixed-Bed De-ionization. An important industrial application of synthetic ion-exchange resins, which were discovered at the Chemical Research Laboratory by Adams and Holmes, has been the de-ionization of water by passage through beds of cation-exchange and anion-exchange resins in series.

With the development of strongly acidic and strongly basic exchange resins, it has become possible to effect de-ionization with a single bed of mixed cation- and anion-exchangers. With this procedure, which originates from the United States of America, the preparation of high quality water is greatly facilitated.

DEMONSTRATION.

Automatic Constant Volume Fraction Collector. The apparatus is designed to collect separate fractions of eluent of constant but predetermined volume. The action is based on the interference of a beam of light falling on to a photoelectric cell by the rising meniscus of the liquid being collected, when a predetermined volume has been reached. The interruption of the beam of light operates a mechanism so that the filled vessel is replaced by an empty one. The particular advantages of this apparatus are that constant volumes of liquid can be collected independently of variations in (*a*) rate of flow, (*b*) drop size of eluent, (*c*) specific gravity of the liquid. In addition each fraction is collected without coming into contact with any portion of the preceding fraction. DEMONSTRATION.

NATIONAL PHYSICAL LABORATORY,
Teddington, Middlesex

PHYSICS DIVISION

Exhibits illustrating some Recent Advances in Acoustical Measurement Techniques at the National Physical Laboratory.

The Absolute Calibration of Microphones at High Frequencies. The absolute free-field calibration of standard microphones at frequencies up to 100,000 c/s. has recently been completed. As far as possible, two independent methods have been used, the Rayleigh Disc for frequencies up to 25,000 c/s. and the method of reciprocity for frequencies up to 100,000 c/s. A model of the arrangement of the apparatus illustrates the procedure adopted. The good agreement between the two methods is shown.

Duct for Acoustical Measurement at Low Frequencies. Free-field acoustical measurements, such as the calibration of microphones and instruments, are commonly carried out in absorbent rooms. At the low-frequency end of the scale, such measurements are limited both in accuracy and scope by residual reflections from the absorbing walls, and by the restricted space in rooms of practical size. The exhibit shows a model of apparatus in the form of a duct with an absorbent termination, now installed at the National Physical Laboratory, which enables plane progressive waves to be set up over a range of low frequencies from 25 to 450 c/s., disturbances due to reflected waves and other causes being reduced to the order of 1%. Results illustrating the performance of the equipment will be shown.

Apparatus for Objective Comparison of Performance Characteristics of Bone Conduction Receivers. The apparatus consists of a quartz cell carrying a resilient pad designed to simulate the impedance of the average mastoid process, to which the bone conductor is applied with a suitable pressure. The output of the quartz crystal is then measured when a known voltage is applied to the bone conductor receiver. Results illustrating the agreement between the objective comparisons between receivers with those obtained subjectively will be shown.

DEMONSTRATION.

Dynamic Measurement of Elastic Constants (in particular of small metal single crystals). A quartz crystal, acting as a transmitter, is mounted on a metal block, and a second crystal, as a receiver, on a similar block. The blocks are pressed into contact and the travel time of a short train of mechanical waves passing from one block to the other is measured accurately, with and without the test specimen between the blocks. The difference between the times gives the velocity of the waves in the specimen, and hence information about its elastic constants.

The waves may be either longitudinal or shear ; one equipment is shown for each type of wave. The wave frequency is about 15 Mc/s., and the wave pulse is repeated many times per second, giving a continuous picture on the cathode-ray screen. The accuracy of measurement is to within rather less than $\pm$ 1/100 microseconds.

By similar techniques the travel times in layer rods may be measured, so that for a specimen a few inches long an accuracy of 2 parts in 10,000 in the velocity measurement may be obtained.

The high accuracy of these pulse methods may also be applied to the measurement of the adiabatic compressibility of liquids; a suitable device (applicable also to corrosive liquids) is exhibited. DEMONSTRATION.

The Conductivity of Metals, Alloys and Allied Materials. The exhibit shows the methods used for determinations over a wide range of temperature of the thermal and electrical conductivities of metallic conductors. Graphical results are displayed for steels, light alloys, carbon and graphite and several pure metals, also for the thermal conductivities of molten metals and alloys.

The markedly anisotropic conducting properties of gallium will be demonstrated. DEMONSTRATION.

METROLOGY DIVISION

Continuous Pneumatic Gauging of Material in Thread or Wire Form. The apparatus is operated from a compressed air supply and gauges automatically the cross-sectional area of fine or coarse wires, plastic filaments or textile slivers, yarns, etc. The material may be drawn continuously through a simple measuring orifice at speeds up to 100 ft/minute and the variations in area recorded autographically. Changes of cross section of the order of 1 or 2% are measurable and the technique has been applied successfully to materials ranging in diameter from 0·007 to 0·25 in. When necessary, a split measuring orifice may be used so as to permit assembly of the orifice around the moving material. Air from a constant pressure source is supplied to the measuring orifice through a controlling orifice and any change of cross section of the material in the measuring orifice alters the pressure in the pipe-line connecting the two. This pressure change is amplified by means of a transducer and a pneumatic proportional amplifier; an original pressure change of $\pm$ 1 inch of water is thereby converted to one of about $\pm$ 6 lb/in^2, which is adequate for recording, sounding alarms or as a signal for controlling machinery. Two forms of transducer have been developed: for the larger diameter materials a spring-loaded diaphragm may be used, but for fine filaments a piston-cylinder arrangement is better since it provides a much quicker response. DEMONSTRATION.

An Apparatus for the Automatic Determination of the Statistical Distribution of the Wire-spacing in Sieves. This apparatus has been designed for measuring the spacing of the warp or weft wires of sieves and expressing the result in terms of the statistical distribution of the actual wire spacings in relation to the nominal. Coarse and fine sieves (down to 300 meshes to the inch) can be measured. The sieve, which is mounted on a carriage traversed by a motor-driven micrometer screw, is projected optically and the magnified image moves across a slit 0·25 in. long by 0·002 in. wide behind which is mounted a photomultiplier tube. Signals from this tube initiated by the passage of the wire shadows across the slit are used to control automatically the following operations: (1) during the passage of each aperture, to admit to an electronic binary counter pulses supplied by a pulse generator geared to the micrometer screw, (2) after each such passage, to record the count by energizing the appropriate member of an associated group of electromagnetic counters and then to re-set the electronic counter in readiness for the next count. During a test, the micrometer screw is driven continuously until the selected number of apertures have successively passed the slit; the readings of the electromagnetic counters at the end of the

run then indicate the statistical distribution of the aperture sizes in relation to the nominal size. In the apparatus demonstrated, analysis into 20 class intervals is provided for, and an additional pair of counters records gross errors of size on each side of the nominal. DEMONSTRATION.

ELECTRONICS SECTION

Automatic Computing Engine. The automatic electronic digital computing engine known as the ' ACE ' is being developed at the National Physical Laboratory. This is a very large machine intended to have a storage or ' memory ' of about 200,000 binary digits. As the first stage in the construction of this large machine, a smaller model with a storage of about 8,000 binary digits, and referred to as the Test Assembly, has been constructed. It is a serial machine in which numbers, punched in decimal form on Hollerith cards, are ' dynamicized ' in binary form as electric pulses with a repetition frequency of a million per second. For storage these pulses are piezo-electrically converted into compression waves in a mercury column, the circulation in the column being maintained unchanged for as long as it is required by a regenerative process.

The exhibit shows the construction of the Test Assembly and illustrates its operation by means of models. DEMONSTRATION.

JOINT FIRE RESEARCH ORGANIZATION,

Boreham Wood, Elstree, Herts

Droplet Populations in impinging Jet Sprays. Samples of spray collected in cellular microscope slides filled with castor oil are photographed by means of a micro-projector and camera. The exhibit includes typical population photographs, the method of recording population counts and measurements by a punched card system, and curves showing the effects of variables such as jet velocity and angle of impingement.

Portable Radiometer. This instrument is used for measuring intensities of radiation from hot bodies at temperatures in the region 700°c. to 1300°c. Although the order of accuracy is not high ($\pm 10\%$ for ambient temperatures between 20°c. and 40°c.) the instrument is light, compact and quick reading (response time of the order of 4 seconds). It consists of a battery-operated Wheatstone bridge with a micro-ammeter as a detector. An adjustable balance potentiometer forms two of the arms, the others being formed by two ' Thermistors'. These are attached to the backs of semi-circular collector plates mounted on the front of the radiometer, one polished and the other coated with platinum black to give a high absorptive factor. This arrangement reduces to a minimum the effect of surrounding air temperature. The instrument can operate on either of two ranges, giving a full scale deflection for a radiation intensity of either 1 cal/cm^2/min. or 8 cal/cm^2/min.

Electrical Analogue of Heat Conduction. The apparatus is for use in solving practical problems on the design of fire resisting structures (e.g., bulkheads and columns) and for research into heat conduction phenomena in general ; it provides a rapid electrical method of solving the Heat Conduction Equation

$$\frac{\delta T}{\delta t} = \frac{K}{\rho S} \nabla^2 T$$

for certain given boundary conditions. This is possible because the flow of (electric) charge in a resistance-capacity transmission line is governed by the same differential equation and mathematical (though not dimensional) analogies may be made between temperature T and E.M.F. E, specific thermal capacity ρS and capacity C, etc. One hour in the thermal experiments is represented by 100 microseconds in the electrical analogue and the whole cycle of an experiment is repeated every millisecond so that results may be presented on a cathode-ray tube. To avoid the difficulty of constructing R-C transmission lines to represent specimens, lumped component lines are used with sufficient sections to give a close approximation to a continuous line. The principal chassis in the equipment includes the master repetition circuit, the time – E.M.F. curve generators, the cathode-ray tube and its associated time-base and time marker circuits. Two time – E.M.F. curves are available, one a step function (of mathematical interest) and the other analogous to a time–temperature curve which is within B.S.D. limits for a test furnace (of practical interest).

FUEL RESEARCH STATION,

Blackwall Lane, East Greenwich, London, S.E.10

The J.D. Sensitive Pressure Controller. This is a form of relief valve designed to maintain a constant pressure in a gas-filled vessel or plant, with a widely varying rate of gas flow.

It consists of:

(*a*) a ball valve in a housing shaped to allow free release of the gas after it has passed the valve,

(*b*) a long adjustable tension spring attached to

(*c*) an adjustable stirrup, which limits the movement of the ball and thus prevents it escaping from its housing.

The example exhibited is suitable for holding any desired pressure between 5 and 50 atmospheres, with atmospheric pressure at the outlet.

It has been used for several months in a Hydrocarbon Synthesis plant operated at 20 atmospheres pressure handling flow rates between 2 and 60 ft^3/hr. When appreciable amounts of oil fog have been present in the gas, the apparatus has also proved an efficient separator.

Distilled Water 'Gun'. A device designed to eliminate the wash-bottle with its inherent troubles of weight, germ-carrying and carbon dioxide contamination. The 'gun' is intended to run from a 10-litre bottle of distilled water under slight pressure generated from a hand bellows.

A modification, using spirit-resisting tubing can be used for organic liquids, or liquids from which moisture must be excluded. The liquid does not come into contact with metal anywhere in the system. DEMONSTRATION.

Vacuum Oven. This is an electrically heated, thermostatically controlled, vacuum oven for laboratory use, with range 50° to 200° C. controlled to ± 0·5° C., according to the type of thermostat used.

The oven is designed to reduce the maintenance necessary with liquid-jacketed ovens and to provide an increased temperature range. DEMONSTRATION.

Stand 117

CHEMICAL DEFENCE EXPERIMENTAL ESTABLISHMENT, Ministry of Supply

Air-driven Spinning Top Sprayer. An apparatus has been developed for the production of homogeneous sprays of small particle size. Liquid is fed on to the centre of an air-driven top of the self-balancing type, which can be rotated at speeds up to several thousand revolutions per second, and centrifuged off the edge. Under suitable conditions of rate of feed, the spray projected from the rotor consists of droplets of almost uniform size together with a number of fine satellites. The latter can be removed by suction or other means thus ensuring the generation of a homogeneous cloud. By this method clouds of droplets as small as 10μ diameter have been produced.

The original apparatus developed by W. H. Walton and W. C. Prewett (*Proc. Phys. Soc.* B, 1949, **62**, 341, is shown. It consists of a top surrounded by a close fitting baffle to deflect escaping compressed air away from the spray; around this is an outer sleeve forming at its upper end an annular gap through which the main spray droplets are projected. Suction is applied to draw away satellite drops, which are not projected beyond the sleeve.

An apparatus of modified mechanical design (K. R. May, *J. Appl. Phys.*, 1949, **20**, 932), incorporating automatic extraction of satellites, is also shown.

DEMONSTRATION.

The Break-up of a Drop in a Stream of Air. This simple system, in which the aerodynamic forces inducing the break-up can be measured, was studied in the course of research on the mechanism of atomization of liquids.

Water drops of known size are allowed to fall into a small vertical transparent wind tunnel down which a steady stream of air of measured velocity is maintained, and their break-up is observed by stroboscopic illumination. The drop is seen to become increasingly flattened and at a critical velocity of the air stream, dependent on the drop size and the liquid, it is blown out into the form of a hollow bag attached to a roughly circular rim. Bursting of this bag produces a shower of very fine droplets and the rim, which contains at least 70% of the mass of the original spherical drop, breaks up later into much larger droplets. The entire break-up is completed in a few milliseconds.

Photographs of various stages of the break-up are also shown. They were obtained by means of an electronic flash tube triggered photoelectrically by the falling drop. Measurements were made of the critical air velocity required to break drops of various sizes, and the influence of the surface tension and the viscosity of the liquid was investigated.

DEMONSTRATION.

Pneumatic Bridge. This instrument was designed primarily to enable small changes in the elastic resistance of the lungs to be followed and measured in animals undergoing artificial respiration, but it may have other applications. The principle of operation is a pneumatic analogy of the simple Wheatstone bridge and the instrument operates as follows:

A suitable respiration pump provides an interrupted unidirectional air flow which is divided into two parallel streams. A variable resistance (e.g. a steam control valve) is inserted in each path to correspond with two limbs of the bridge,

while the remaining two limbs are formed by the lungs in the one case and by a loaded rubber reservoir in the other. To use the electrical analogy further, the ‘ galvanometer ’ takes the form of a differential metal bellows manometer carrying a writing lever suitable either for smoked paper or ink recording and is connected at appropriate points in the bridge. In use, the resistances are adjusted so that no deflection of the writing point is obtained when the lungs are inflated to a normal extent, the trace then being substantially a straight line. Any subsequent change in the resistance of the lung, such as might be produced by drugs, is indicated by the appearance of ‘pips’ above or below the line according to the direction of the change, while the magnitude of the change is indicated by the amplitude of the pips. To enable the lungs to deflate passively between pump strokes, a simple automatic release valve is incorporated. In the model shown, the lungs are represented by a mechanical device. DEMONSTRATION.

(The above are exhibited and described by permission of the Chief Scientist, Ministry of Supply.)

Stand 118

ROYAL AIRCRAFT ESTABLISHMENT,
Ministry of Supply, South Farnborough, Hants

Electronic Curve Follower. When recorded information is to be fed to a differential analyser or an analogue computer it is usually necessary to translate it into voltage form, and the electronic curve follower will perform this operation with continuous line records.

In the model exhibited the record is an opaque line on transparent film drawn at a constant rate between a cathode-ray tube and a photocell. The fluorescent spot on the cathode-ray tube is oscillated across the opaque line, at 3 kc/s. and about 1 mm. amplitude, so that the photocell receives signals from each side of the line in alternate half-cycles of the spot oscillation. These signals are amplified and fed to a phase sensitive rectifier which discriminates between the alternate half-cycles and gives a D.C. push-pull output proportional to the displacement of the centre of oscillation of the spot from the centre of the line. This D.C. output is now fed back to the deflector plates of the cathode-ray tube in the appropriate sense which causes the spot to lock to the line. It should be noted that the spot is effectively locked to the *centre* of the line. The deflector plate voltage is a measure of the ordinate of the record.

If the photocell views the cathode-ray tube by reflection from a bright patch on a machine part, on which is a black line, the motion of the part can be followed and the deflector plate voltage used to examine it conveniently, as is required for example when balancing rotating members.

Isograph. This is an electrical instrument for solving complex polynomial equations with real coefficients, and is based on the mechanical isograph described in the *Bell Laboratories Record* Vol. 16 (1937).

The operation of the instrument is based on drawing the Argand diagram of

the polynomial corresponding to a given value of modulus of the independent variable. By varying the value of this modulus until the Argand diagram passes through the origin, the modulus of each of the roots may be found, while the argument of the root may then be found by means of a marker on the curve which can be made to correspond with any value of argument.

All the real and imaginary terms of the polynomial are generated as voltages of a supply of frequency 16 kc/s. An oscillator produces an output of about 5 volts which is taken to 7 potentiometers, each having a logarithmic law connecting output with displacement. In this way the involution of the powers of the modulus and the multiplication by the coefficients is achieved by a simple addition of the displacements. Step-by-step switches in conjunction with continuous wire-wound potentiometers provide a continuously variable output of good accuracy over a wide range of output.

The resolution of each term into real and imaginary parts is done by magslip resolvers continuously rotated by an electric motor, and the Argand diagram is displayed as a continuous curve on the screen of a cathode-ray tube. The argument of the root is marked on the curve by an interruption produced by a commutator rotating with the resolvers, and the same device, by returning the spot to zero once per revolution, ensures that the true zero is always marked on the display.

Measurement of Ball Race Friction. The apparatus measures the torque interacting between the inner and outer members of a ball race as one is rotated with respect to the other. A carriage supporting the inner race is mounted on crossed spring hinges forming a frictionless pivot. Deflection of the carriage is detected by an inductive pick-off operating on 400 c/s. A.C., the signal from which is fed via an amplifier and phase sensitive rectifier to a torque motor attached to the carriage. This combination constitutes a so-called 'electric spring', the stiffness of which is much higher than that of the mechanical spring hinge. The outer race is mounted in a flywheel which is turned slowly by a D.C. motor. The current flowing through the torque motor coil is a measure of the torque interacting between the two members of the bearing, and the range of measurement of the apparatus can be varied by shunts across the meter movement and the torque coil. Calibration is carried out by dead weights and a sensitivity of 0·01 gm/cm. is readily obtainable.

Multi-Channel Continuous Trace Recording†. The galvo-camera recorder provides, after photographic processing, graphic records on the same time base of 12 quantities whose values are varying at frequencies within the range zero to 2,000 cycles per second. To cover the whole of that frequency range there are available galvanometer armatures of various natural frequencies and sensitivities, and amplifiers to handle resistance, inductance or electromagnetic generator pick-ups and deliver the requisite current. For more slowly varying quantities the most sensitive galvanometers available for this recorder may be used, without amplifiers, in conjunction with thermocouples or any measuring element arranged to vary resistance values in a Wheatstone bridge. Since the galvanometer armatures of different natural frequencies are interchangeable, the 12 channels may be allocated, in any proportion, between high and low frequency signals.

In the demonstration separate channels of the galvo-camera recorder are connected :

via separate channels of the amplifier to

(i) an acceleration-inductance pick-up of range $\pm 12g$ which may be vibrated to show high frequency response,
(ii) a similar pick-up which may be inverted to show sensitivity,
(iii) a pressure-inductance pick-up of range $\pm$ 10 lb/in^2,
(iv) a force-resistance (bonded) pick-up,
(v) an acceleration-resistance (unbonded) pick-up ;

without interposing amplification, to

(i) a thermocouple,
(ii) and (iii) pitch and roll potentiometers on a free gyroscope,
(iv) a Desynn transmitter rewired as a Wheatstone bridge,
(v) a pressure-resistance (unbonded) pick-up.

Stand 119

TELECOMMUNICATIONS RESEARCH ESTABLISHMENT, Ministry of Supply

with METEOROLOGICAL OFFICE, Air Ministry

Radar Sonde. A new meteorological sounding system has been designed, using radar. A balloon-borne transponder and a single ground station are used to measure wind speed and direction automatically up to slant ranges of 100 miles. Also, atmospheric pressure, temperature and relative humidity are measured at regular intervals during the ascent and descent of the transponder.

The ground station transmits narrow pulses regularly on a wavelength of 2 metres, the pulses being returned by the balloon-borne transponder on a wavelength of 10 cm. By measuring the transit time of the pulses to and from the transponder, the distance of the balloon from the ground station can be found. An auto-follow aerial receiving system of high resolution enables the elevation and bearing of the balloon with respect to the ground station to be determined automatically. This information is fed into a computer which calculates the horizontal components of the speed and direction of motion of the balloon and hence gives speed and direction of the wind.

In addition the balloon-borne unit can carry elements sensitive to the pressure, temperature and relative humidity of the atmosphere. The magnitude of these parameters is accurately telemetered to the ground station over the same pulse channel as is used for the range measurement. One of the main features of the balloon-borne unit is that it is enclosed in a thermally insulating container ; hence the batteries and telemetering circuits are maintained at approximately ground temperature throughout the flight.

The exhibits illustrate some of the techniques used, and experimental balloon-borne units are shown. DEMONSTRATION.

TELECOMMUNICATIONS RESEARCH ESTABLISHMENT, Ministry of Supply

Infra-Red Radiation Pyrometer. A two colour radiation pyrometer has been designed which uses a lead sulphide photoconductive cell as detector. It

is suitable for measuring the temperature of bodies in the range 250°C. to 3,000°C.; the lower limit may be extended by the use of either a lead selenide or a lead telluride cell. The measurements are independent of the distance of the source, its size and its absolute emissivity. The temperature of cyclically moving bodies may also be measured.

The radiation from the hot body passes through two suitable filters and the filtered beams are interrupted cyclically and 180° out of phase, before being combined at the lead sulphide detector. The intensity of one beam is changed by means of a calibrated variable aperture, until the signal recorded by the cell is zero. The position of the aperture then gives a direct measure of the temperature. DEMONSTRATION.

Locked Oscillators for Frequency Multiplication. One of the methods of causing bench oscillators at high frequencies to have a good frequency stability is to multiply up from a crystal-controlled source at low frequencies. The traditional distorting amplifier needs many stages and controls, for it will not easily multiply by more than three, and it is not sharply selective of the wanted frequency. The locked oscillator is sharply selective. It can multiply by ten in one stage and it delivers more power than any other multiplier using the same valve. The oscillators shown are parts of a system for obtaining power at 3,000 Mc/s. from a crystal-controlled source at less than 10 Mc/s. In each oscillator, the input locks an oscillator at the fundamental frequency; in the anode circuit of the oscillator valve is a circuit tuned to the tenth harmonic. This is the input which locks the oscillator in the next stage, and so on. DEMONSTRATION.

Two Co-ordinate Recorder. The curve of current against voltage of a resistor or other impedance can be obtained from a cathode-ray tube in a fraction of a second or from successive readings of conventional instruments in a few minutes. This instrument is designed to cover the time interval between the two and trace a curve on paper approximately as fast as the current can be manually adjusted. Two movements, each from a 5 ma. recording meter, are connected by linkages to a pen which traces a curve on squared paper. The result is closely rectilinear up to 3 ma. The movements are critically damped and have a time constant of about 1 second. DEMONSTRATION.

A Narrow-Band Audio Amplifier. The amplifier is designed to select a 1 kc/s. signal from a background of noise. The bandwidth is varied by varying the amplification at mid-frequency. It will be shown with a gain of 72 db. at 1 kc/s. and a bandwidth of 1 c/s. It is an untuned audio amplifier with negative feedback. The feedback network is a twin-T, a frequency bridge which has no output voltage at the frequency for which it is balanced. Except for a very narrow band about the balance frequency, feedback voltages are passed with no significant attenuation. As a result, the gain of the amplifier is similar to that of a tuned amplifier controlled by a resonant circuit of very high Q given by mid-frequency gain divided by 4. The system as a feedback amplifier must satisfy the Nyquist criteria. The phase condition is somewhat difficult to satisfy, for the phase change through the twin-T network changes with frequency from very close to $-90°$ to very close to $+90°$, so that the amplifier itself can be allowed only a limited variation of phase shift. This has caused failure in attempts

to make a twin-T amplifier for 2 Mc/s., but it is believed that one could be made for 1 Mc/s. DEMONSTRATION.

A Laboratory Oscilloscope. Normal oscilloscopes will measure the amplitude of input voltages to accuracies that are limited by instability of the trace and poorness of focus. This instrument was designed to be considerably better than normal and to measure to 1%. Its time-base has a range of 10 c/s. to 1 Mc/s. and its amplifiers a range of 10 c/s. to 5 Mc/s. A 12-inch tube, electrostatically focused and deflected, was found to have the highest ratio of tube diameter to spot diameter. DEMONSTRATION.

Signal Generator, 600 – 1,215 Mc/s. The signal generator consists of two units, a power supply providing stable D.C. outputs (including heater supply) and a unit comprising the oscillator, attenuator, monitoring and modulating circuits.

The monitoring element is a bolometer and on C.W. the output is automatically controlled to maintain a balance in the bridge circuit in which the bolometer is incorporated. For square wave and pulse modulation the control circuit is used to supply sufficient low frequency power to maintain the bolometer at the correct resistance so as to avoid difference in peak power levels on pulse and C.W. due to variations in the bolometer matching. The circuit incorporates safety measures to decrease the possibility of burning out the bolometer by overloading.

The piston attenuator output circuit has been designed to give reasonably constant impedance and to avoid the 6 db. per octave change in output level which is a feature of the normal resistive loop pick-up. The frequency stability and bandwidth of the oscillator should be adequate to enable it to be set to recognisable audio beat with another stable oscillator. The screening and filtering are adequate for use at a level of 130 db. below 1 milliwatt.

Concise details are :

Modulation : Square wave — 1 kc/s.
External pulse — direct.
External pulse — pedestal, to avoid starting delay.
External sine wave — up to 30%.

Accuracy on C.W. : 0·1 db.

Accuracy on modulation : 1·0 db.

Discrimination of attenuator : 0·02 db.

Output impedance : 70 ohms (reflection coefficient less than 0·1).

The instrument is R.A.F. Signal Generator Type 110. DEMONSTRATION.

The Detection of Low Level Illumination by Photoelectric Means. There are four main limitations to the performance of photoelectric photometers near threshold : true dark current (spontaneous photo-cathode emission), leakage current, shot noise associated with the total photo-cathode current, and amplifier noise. At low signal levels, amplification by secondary emission multiplication is relatively noise-free and hence a photo-multiplier can be used to raise the level of the photo-cathode signal considerably above the noise introduced in a thermionic amplifier.

The most sensitive use of a photo-multiplier, in which only the shot noise factor is of significance, is obtained by using a mechanical light interrupter to give an A.C. output which can be followed by a narrow band A.C. amplifier. The main disadvantage of this method is that the actual light-detecting portion of the

photometer is made larger than the photo-cell by the addition of the interrupter and its driving motor; stabilization of motor speed and amplifier frequency is also required. This practical difficulty can be avoided when the true dark current is small by modulating dynode potentials for the conversion to A.C. The threshold is then determined by one of three factors: the amount of dark current, second harmonic break-through from the modulator circuit, or the total photo-cathode current shot noise. Dynode modulation is used in the photometer demonstrated.

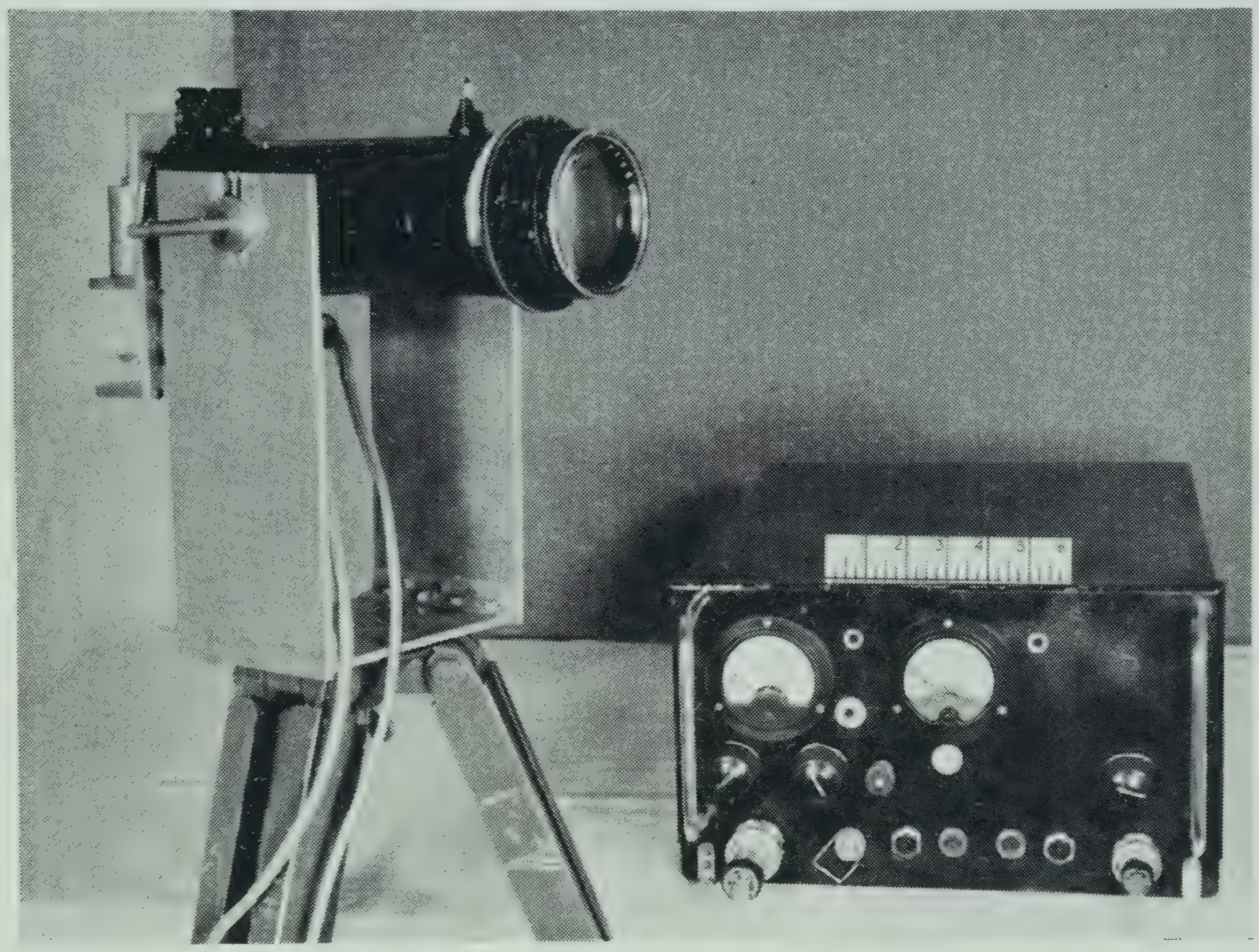

Figure 1. Photoelectric photometer.

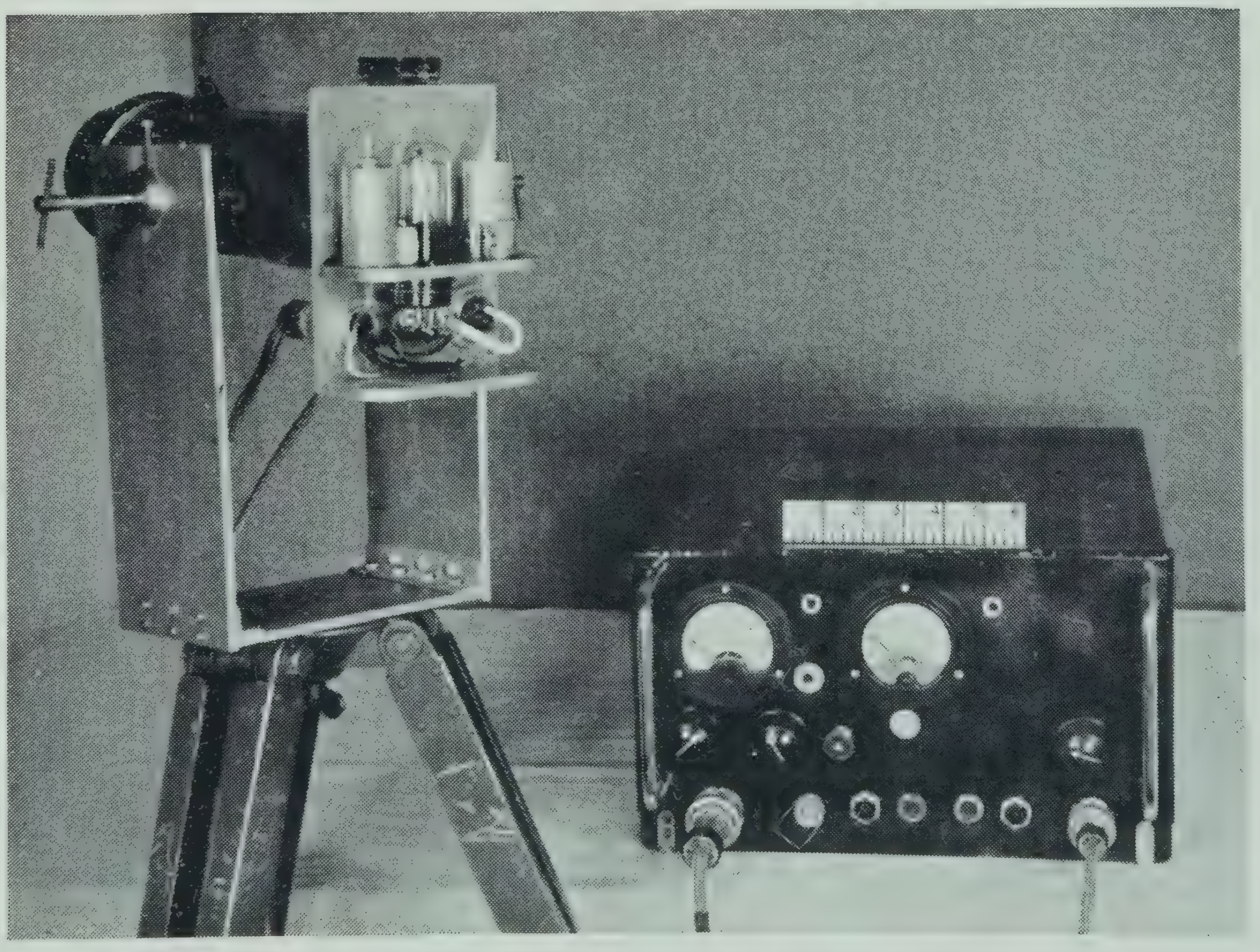

Figure 2. Photoelectric photometer showing photocell.

Another difficulty encountered in absolute measurement is the variation in photo-cathode sensitivity and gain of the photo-cell and any succeeding amplifier. A standard screen of low brightness, with very slow and known decay (a few per cent per year) can be obtained from radium-activated paint and used to calibrate the photometer.

Demonstration Apparatus.

(i) A photometer consisting of a detector and an amplifier is shown. The detector contains an R.C.A. 931A photo-multiplier and a lens system limiting the field of view so that the photometer is suitable for measuring discrete sources or the average intensity value over any desired field.

The photo-multiplier is modulated by applying a push-pull drive on to two adjacent dynodes. Since the curve relating amplification and the voltage level of one dynode with respect to its neighbours is of square law form, with the peak at the central symmetrical position, the photo-current is cut on and off at twice the modulation frequency. The push-pull supply is adjusted so that induced second harmonic signals are balanced out. A narrow-band amplifier raises the signal to a suitable level, rectifies it and displays it on a linear meter. The voltage supply to the photo-cell is stabilized by a simple series valve and the amplifier incorporates negative feedback. A standard screen is used for calibration. The threshold is about 10^{-10} lumen.

(ii) The E.M.I. linear photo-multiplier has small leakage as well as small true dark current and high cathode sensitivity. This is demonstrated by its use as a direct light measuring device. Here the shot noise power of the total multiplier current is measured by a thermal meter, which thus indicates input light intensity directly.

The limit to its sensitivity is the shot noise associated with the dark current and leakage current — an average tube gives a threshold of about 10^{-10} lumen.

Using this photo-multiplier with the dynode modulation technique, an even lower threshold could be achieved. DEMONSTRATION.

New Materials — Ferrites and Ceramics

Thermostat Control using High-K Dielectrics. The permittivity of a high-K dielectric changes rapidly and regularly with the temperature above its Curie point. This property makes the dielectric suitable as a thermometer element and use has been made of it in a thermostat control. A commercial condenser of K 3000 material forms one arm of a 50 c/s. bridge, the heating current of a thermostat bath being switched on and off by the amplified output from the bridge. The phase relation between the input and output of the bridge gives the necessary discrimination between rising and falling temperature. DEMONSTRATION.

Thermostat Control using Ferrite Magnetic Materials. All magnetic materials lose their magnetic properties above a certain temperature — their Curie point — at which their magnetism changes rapidly. In certain materials of the $RO.Fe_2O_3$ class, R being a divalent metal, the Curie point is below 200°c.

Relays, which make or break a circuit at the Curie point of the ferrite material, can be used as thermostats, and a relay has been constructed using a manganese-zinc ferrite which can give a warning when a critical temperature is reached. The relay is very robust and free from effects caused by vibration.

DEMONSTRATION.

Stand 120

ATOMIC ENERGY RESEARCH ESTABLISHMENT, Electronics Groups, Harwell, Didcot, Berks.

Alpha Assay Equipment. This equipment is a scintillation counter for the accurate measurement of alpha active samples with special suitability for samples of large area and low activity. Scintillations are produced by alpha particles on a ZnS (Ag Ni) screen 4 inches square lying at the focal plane of a silvered ellipsoidal shell which directs the light on to the cathode of a multiplier photocell in the second focal plane. Pulses produced at the photomultiplier anode are discriminated and amplified sufficiently to operate a mechanical register. Stabilized supplies are produced by the power unit. An overall efficiency of about 35% is obtained at a background rate of 10–20 counts per hour. Stability is better than $\pm$ 2%. DEMONSTRATION.

Gamma Counting Equipment. This equipment is suitable for gamma activity measurements where high efficiency gamma counting is essential. Gamma quanta, absorbed in a large transparent block of luminescent material (e.g., NaI + $\frac{1}{2}$% Ti) produce fast secondary electrons which in turn produce scintillations. These are observed by an eleven stage electron multiplier photocell. After suitable amplification pulses from the photomultiplier are discriminated and counted. This method of counting is about 15% efficient for 1 MEV. gamma quanta, with higher efficiency for lower energies, the noise limit from the photocell corresponding to light flashes from approximately 5KV. electrons. Resolution times down to 2×10^{-8} seconds can be achieved. DEMONSTRATION.

Instruments for the Measurement of Radium fixed in the Body. Two instruments are shown for the measurement of radium in the body. In the first of these, a direct measurement of gamma radiation is made using a pressure ionization chamber and sensitive D.C. amplifier. In the second instrument, the radium content is inferred from a measurement of the radon in the breath.

The first instrument consists of an ionization chamber with an effective volume of 4·7 litres, filled with argon to a pressure of 20 atmospheres. The natural gamma and cosmic ray background produces a current of 10^{-13} amp. and this is fed into a D.C. amplifier of the vibrating condenser type. Here the D.C. is converted to A.C. by a vibrating reed unit, amplified, and rectified for operating a 1 ma. meter. The D.C. output is applied to the input as negative feedback. Zero drift in the amplifier corresponds to about 2×10^{-15} amp. so that quite small changes in background can be measured. Full scale deflection may be 2×10^{-13} amp. A response time of less than 1 second is possible, but in order to reduce statistical fluctuation of the ionization current to the same order as zero drift, a time constant of about 30 seconds is deliberately introduced.

The figure 10^{-13} amp. for background corresponds to about 7 μr/hr. One microgram of radium at a distance of 35 cm. from the centre of the ionization chamber would be sufficient to double this figure, or alternatively 0·1 microgram at a distance of 25 cm. would produce an increase in reading of nearly 20%. The practical difficulty in making the measurement is that contamination of the skin may easily mask the true readings. Sensitivity would also be reduced by absorption in the body.

The second instrument makes use of the fact that, of the radon produced by radium in the body, about 40% appears in the exhaled breath ; so 0·1 microgram of radium gives rise to about 10^{-12} curie of radon per litre of expired air at normal breathing rates. The breath sample is collected in a plastic bag and introduced into a previously evacuated ionization chamber of 4 litres capacity. Alpha particle disintegrations produced in the chamber give rise to electrical pulses which are amplified and recorded by a Post Office call register. The ionization chamber is of special construction to reduce the effect of natural radioactive contamination of the wall materials (which would otherwise be a serious drawback at the low counting-rates involved), while maintaining a high counting efficiency for the daughter products of the radon in the sample. The chamber background corresponds to about 3×10^{-14} curie of radon per litre. DEMONSTRATION.

Liquid Sample Collector. This equipment is used in conjunction with an ion-exchange column to separate mixtures of radioactive fission products. It comprises (*i*) an ion-exchange column ; (*ii*) a special G-M counter which counts the beta particles emitted by the fission products ; (*iii*) a liquid sample collector designed to collect up to 36 samples ; (*iv*) a recording ratemeter ; (*v*) a relay control unit.

The process of ion-exchange results in each of the various radioactive products flowing out of the column in turn. Consequently the ratemeter monitoring the effluent of the column shows an increase in the counting rate as each of the radioactive elements passes the G-M counter. This increase of counting rate activates the control mechanism and a new collecting bottle is brought under the column. Similarly each successive peak of activity gives a signal that a new bottle is required. To guard against any bottle becoming too full a photoelectric system monitors the position of the meniscus and gives a start signal to the collecting mechanism if any bottle is filled beyond a predetermined level.

The operation is fully automatic and enables a separation to be carried out without manual attention. DEMONSTRATION.

G-M Counter Survey Meters. This exhibit comprises three instruments. The first instrument has been designed for use in prospecting for radioactive ores, its sensitivity being chosen so as to provide a means of selecting materials which contain sufficient radioactive material to be useful ores and rejecting those which do not.

The radiation sensitive element in the instrument is a Geiger-Müller tube, which is designed to have a very low operating voltage (about 400 v.) in order to keep down battery weight. The whole of the operating voltage for the G-M tube is supplied directly from miniature hearing-aid batteries.

The G-M tube works into a count-ratemeter circuit which gives a meter indication of the gamma-ray intensity and also makes each G-M tube triggering audible as a click in a pair of headphones. Cold cathode trigger valves are used in this circuit in place of the usual filament valves, in order to reduce the power drain on the batteries, and this leads to a battery operating life of about 2,000 hours.

The G-M tube has a count rate on normal cosmic-ray and gamma-ray background of about 75 per minute. The calibration of the instrument in terms of meter reading plotted against G-M tube count rate is made non-linear, so that a

count rate of 1,200 per minute gives one quarter full scale deflection, while full scale deflection requires a count rate of about 36,000 per minute.

The weight of the instrument is about 6 lb. and it is normally carried in a canvas satchel provided with a web carrying harness. Since the instrument is intended for use in all climates, it is hermetically sealed to exclude moisture.

The other two instruments are variations of this. The first is similar but has two linear scales in place of the non-linear scale. Full scale deflection corresponds to count rates of 1,000/min. and 10,000/min. respectively. The second instrument is more elaborate and is provided with a number of interchangeable probes each containing a G-M counter. It is suitable for both beta- and gamma-radiation surveys. DEMONSTRATION.

Stand 121

RADAR RESEARCH AND DEVELOPMENT ESTABLISHMENT, Ministry of Supply

Automatic Phase Recorder Demonstrating the Properties of a Centimetric Radar Lens. The instrument is designed to record radio-frequency phase variation along any desired paths as determined by the traversing mechanism. The results are produced as pen recordings of phase versus displacement.

Measurements are accurate to $\pm 5^\circ$ for any phase variation, and a simultaneous variation of up to 40 db. in the attenuation of the device being measured does not reduce the accuracy of phase measurement. Since the phase measurement is carried out at a fixed intermediate frequency the operating frequency may be varied by changing only the radio-frequency head.

The demonstration shows the recorder in use for the investigation of the properties of a new type of centimetric radar lens.

Magnetic Fluid Clutch. This clutch is of a novel form which originated in America. Clutches made in this country are now on test by the Defence Establishments, as there is a possible application in the field of servo-mechanisms. It is based on the phenomenon that a suitable mixture of iron powder and oil can be relatively liquid under normal conditions and relatively solid when subjected to a magnetizing field. In a magnetic fluid clutch, the space between an input and an output member is filled with such an iron–oil mixture, and the torque which this arrangement can transmit is found to be an almost linear function of current in a magnetizing coil ; a few watts can control several horsepower.

The exhibit demonstrates the basic mechanical properties of a typical mixture, and sample clutches are shown exploded and assembled. It includes a 1 H.P. reversible unit in operation performing a typical duty for radar work, and the response of this mechanism is appropriately displayed.

Rapid Setting Micrometer. 0 – 7 inch. A length measuring mechanism, though primarily designed for use with precision piston attenuators, has application whenever it is necessary to make rapid length measurements of medium precision over a wide range. The instrument exhibited provides a direct measurement of

lengths up to 7 inches to an accuracy of $\pm$ 0·0005 inch, by automatic interpolation over a series of $\frac{1}{4}$ in. intervals provided by standard ground steel rollers. The time taken for a measurement is a few seconds.

Schlieren Optical System. A Toepler Schlieren optical system is used to demonstrate the presence of ultrasonic waves in water. A quartz crystal in contact with the water is driven from a push-pull oscillator at 1·5 Mc/s. The waves are reflected from the end of the tank and form standing waves along the length of the tank. By means of the Schlieren system, these waves are made visible and projected on a screen.

With this equipment, the properties of ultrasonic waves can be demonstrated. Reflection is easily shown, and, by immersion of materials in the tank, partial or complete absorption of the waves can be observed. Concentration of the waves by means of a lens system can also be demonstrated.

Stand 122

SIGNALS RESEARCH AND DEVELOPMENT ESTABLISHMENT, Ministry of Supply

F-M Deviation Meter No. 3. The Frequency Modulation Deviation Meter No. 3 is an instrument for measuring deviations up to 500 kc/s. with modulation frequencies up to 120 kc/s. at an R.F. carrier frequency between 20 and 100 Mc/s. The overall inaccuracy from all causes is 2%. The harmonic distortion developed by the instrument is better than − 60 db. The deviation can be read directly upon a 3-range meter, and terminals are provided for either visual or aural presentation.

The incoming signal is heterodyned and the resulting I.F. is amplified in a video amplifier. It is then limited and applied to a resistance-capacitance differentiating circuit which has a double D.C. clamp. The modulation is extracted by means of a lowpass filter, and amplified by a resistance-capacitance coupled amplifier, which has a large amount of negative feedback. The modulation is then measured on a valve voltmeter which is calibrated in deviation.

In order that this shall be a working exhibit, a signal source will be provided by the Signal Generator No. 13. This is an F-M/A-M generator and covers the frequency range 20 – 80 Mc/s. in two bands, 20 – 40 Mc/s. and 40 – 80 Mc/s. Four internal modulation frequencies are provided as well as provision for external modulation. On A-M the modulation depth can be varied up to 80%, and the accuracy of indication is within 2%. On F-M deviations up to 300 kc/s. and 600 kc/s. on the two R.F. ranges respectively can be obtained, and the accuracy of indication is within 3%. External modulation frequencies up to 20 kc/s. can be employed on A-M and up to 120 kc/s. on F-M. Provision is also made for a square-wave output up to a repetition frequency of 120 kc/s. Considerable care has been taken in the design to ensure that there is very little spurious F-M upon an A-M signal, and vice versa. An illuminated film drive scale is provided with an effective length of 9 ft., and crystal check points are provided at intervals of 100 kc/s.

Leakage Testing Apparatus.

(*a*) *Component Leakage Test Apparatus.* This apparatus has been developed to measure the air leakage into sealed components without disturbing their seals or introducing additional test inlets. Components such as hermetically sealed vibrators and relays can be tested in a few minutes and accurate measurements of leakage made at pressures between 10 and 20 lb/in^2. Direct readings of volume at the test pressure are obtained by a special pressure balancing device, leakages of the order of $\frac{1}{100}$cm^3 being readily discernible. Care has been taken in the design to limit the effects of temperature change, and the main chamber seals are rendered foolproof by means of a double seal operating on the 'guard-ring' principle.

(*b*) *Micro Leak Test Gear.* This device is used for the measurement of very small air leakages on panel mounted components such as sealed terminals, etc. and functions as a differential manometer. The novel feature of the device is the extremely sensitive indicator which consists of a bead of oil in a horizontal capillary tube. Measurements of leakages as low as 1/1000 cm^3 can be made directly by means of a balancing device, the calibrated movement of which restores the system to equilibrium.

A Single-Tee Impedance Bridge for 50-100 Mc/s. This bridge measures the 'direct partial impedance' between the two live terminals of an earthed three-terminal network. The impedance is obtained directly from the readings of two dials in the form $R + jX$.

Venner Motor Driven Tuning Mechanism. This mechanism is used to reset a shaft to one of three pre-determined positions in a total travel of four revolutions. Each pre-set position may be anywhere in the travel of the shaft, and alteration of one position will not influence the other two.

One application is to the tuning of an oscillator to three pre-set frequencies, all adjustments being made from a control panel.

The shaft resetting accuracy achieved is better than $\pm$ 2 minutes of arc, and this will be demonstrated by an optical method.

Stand 123

ARMAMENT RESEARCH ESTABLISHMENT,

Ministry of Supply

High Speed 'Streak' Camera. 'Streak' cameras have been fairly extensively used in the investigation of flame propagation and detonation processes. The 'streak' is produced by scanning an image of a very narrow section of the luminous subject in a direction perpendicular to the section, and the resultant trace is recorded photographically. The record thus displays the growth of the explosive process, in the direction selected by the section, on a time scale which is dependent on the speed of the scan. The section is obtained by using a slit to confine the light from the source to a very narrow band. The slit could be placed as near as is practicable to the source itself but it is usually advantageous

to locate it within the optical system. This method is used in the present camera. Since the processes under investigation are usually changing at a very high rate their analysis requires a correspondingly high scanning rate. This is obtained from a mirror rotating at high speed.

The system thus consists basically of the following components :

(1) A primary lens giving a reduced image of the object.

(2) A slit in the primary image plane whose position relative to this image determines which narrow band of the object shall be observed.

(3) A secondary lens giving a magnified image of the primary slit image.

(4) A rotating mirror behind the secondary lens.

(5) An arc on which stationary film is mounted and on which the final image is focused via the rotating mirror.

In the present camera this system is duplicated in order to allow horizontal and vertical sections to be viewed simultaneously. Two independent optical systems are used in conjunction with a single rotating mirror of square section. By including stationary 45° mirrors in the optical paths it is arranged that adjacent faces of the rotating mirror can be used for the two records. Separate films are used for the two records, each consisting of an approximate quadrant of about 18 in. radius. The centres of these quadrants are offset from the centre of rotation to give the best fit to the image path. The mirror is rotated in partial vacuum at approximately 40,000 r.p.m. by a 4×1 belt drive from a 1 H.P. motor. Under these conditions the writing speed is approximately 4 mm. per microsecond.

Arrangements are included for altering the primary lens to suit various object distances. The mounting provides for adjustment of the line of view, and a sighting telescope is attached. Provision is made for daylight loading. For synchronization and speed measurement a magnetic pick-up is used which feeds into a tachometer and into a firing circuit. The latter is primed by the operation of the mechanical shutters but synchronizes a firing pulse to any desired phase of the rotating mirror. It is thus ensured that the record is obtained at the optimum presentation of the mirror faces.

Electronic Tachometer and Synchronizer. The tachometer and synchronizer was designed as an ancillary to the streak camera. It enables the rotational speed of the mirror to be measured to an accuracy of within 0·1 per cent and the initiation of the phenomenon under observation to be synchronized to within a few degrees of any desired rotational position of the mirror.

A portion of the spinning system is magnetized along a diameter and the voltage induced in a pair of small coils by the rotating magnetic field is conveyed by line to the tachometer. A simple frequency meter is used to give an approximate value for the rotational speed and an accurate value is obtained by combining the unknown frequency with that produced by a highly stable local oscillator and then measuring the difference frequency. Speeds between the limits 36,000 r.p.m. to 60,000 r.p.m. can be measured to an accuracy within 0·1 per cent with the existing local oscillator, which has ten switched frequencies to cover this range.

The sinusoidal voltage from the pick-up coils is also passed through a squaring circuit so that a leading edge is produced at a certain phase of the rotation. This edge is used as a reference time for a delay system so that an initiating pulse can be generated at a fixed but controllable time later.

The Twelve Channel Transient Recorder. This instrument is capable of recording twelve simultaneous transients the duration of which may range from 50 microseconds down to a small fraction of a microsecond. It is intended for non-repeating transients and the maximum time resolution at the highest sweep velocity is one hundredth of one microsecond.

Twelve cathode-ray tube displays are photographed by a single half-plate camera. The tubes are arranged electrically in four groups of three and any group may be connected to any one of four time-base generators. These generators provide a linear sweep potential which gives a trace duration ranging from one microsecond up to fifty microseconds, and each one is capable of driving up to twelve tubes. Consequently all tubes may be operated from the same time-base or alternatively various groups of tubes may have a different trace duration. It is also possible to stagger the various tube groups in time so that records can be obtained which bracket a longer time than an individual trace duration.

The cathode-ray tube used is the VCRX 294 which was developed by the G.E.C. Research Laboratories for the Ministry of Supply. It works at an overall voltage of 8 kv., half of which is applied to a post deflection accelerator ring. Connection to the front plates is made through low capacity low inductance couplings brought out through horns in the neck of the tube.

A timing pulse generator is included to provide time calibration of the traces obtained. This produces pulses of 10^{-8} second duration at intervals of 2 microseconds, 0·5 microsecond or 0·2 microsecond apart. These pulses, which have an amplitude of about 20 volts, are superimposed on the traces. Provision is also made for ‘ piping ’ out these marker pulses so that other recorders can be synchronously calibrated.

The Electrostatic Spiral Oscillograph. This instrument is a chronograph with a time resolution of 10^{-8} second but capable of measuring times up to 50 microseconds duration. The display is in the form of a collapsing spiral with a rotational frequency of 500 kc/s. The ‘ events ’ to be timed are impressed as beam blanking pulses. The rotational speed is governed by a crystal controlled oscillator and a timing calibrator which produces pulses at half microsecond intervals is included.

As many as sixty ‘ events ’ can be recorded on the spiral trace provided they do not occur within 0·2 microsecond of each other and a time interval of 50 microseconds can be measured to an accuracy of within 0·02%.

Synchronizing Pulse Generator. This instrument was produced as a means of synchronizing a number of high speed transient recorders and impulse generators, and also for providing identification marks on the traces obtained. There are four output channels, each channel giving out simultaneously a positive pulse of 300 volts amplitude and a negative pulse of 200 volts amplitude.

The first channel A provides the pulses at ‘ zero ’ time and the second channel B produces the pulses at a time which can be varied between 0·3 microsecond and 100 microseconds later. The third channel C can be delayed relative to A or to B with a similar range of delays and the fourth channel D can be delayed relative to A, B or C. All the delay settings are independent so that the delay of two channels can be maintained constant whilst the delay of both relative to a third can be varied. The synchronizer can be tripped manually by a button

on the panel or by the application of a positive pulse to the trip terminal.

Consequently a number of the synchronizers can be connected in parallel or in cascade to provide a wide variety of pulse distributions of either polarity. The pulse position is reproducible to within 10^{-8} second, for all channels.

(The above are exhibited and described by permission of the Chief Scientist. Ministry of Supply.)

Stand 124

ADMIRALTY EXPERIMENTAL ESTABLISHMENTS, ROYAL NAVAL SCIENTIFIC SERVICE,

Queen Anne's Mansions, St. James' Park, London, S.W.1

Narrow-Band Heterodyne Frequency Analyser. When carrying out investigations dealing with the noise and vibration of machinery and structures it is often necessary to undertake a frequency analysis of the noise or vibration spectrum.

The narrow-band heterodyne analyser shown, when coupled to microphone or vibration pick-up equipment fulfils this requirement. It embodies the following features :

(i) A manual control of frequency to give readings of the relative amplitude of component levels on an indicating meter having a uniform decibel scale.

(ii) An automatic spectrum scanning device to enable permanent records to be made of the spectrum analysis on an external pen recorder or by photography with an oscilloscope.

(iii) Three alternative bandwidths for analysis. Interchangeable electro-mechanical filters are fitted for bandwidths (measured at 70% each side of maximum amplitude) of 1·2, 5 and 12 c/s.

Single element electro-mechanical filters were chosen in preference to multi-element types in order to ensure a high order of stability and because with a single element filter allowance can be made where necessary for the inevitable errors introduced by high rates of scanning.

Brief Specification.

(i) *Frequency range* — 30 c/s. to 27,000 c/s.

(ii) *Input* — the maximum input signal at 600 ohms is 0·3 volt r.m.s., but by the use of a pre-set 10 db. attenuator in 1 db. steps, adjustment can be made for input terminal volts up to 1 volt r.m.s.

(iii) *Dynamic range* — greater than 60 db.
By use of the most selective electro-mechanical filter, harmonic analysis of a complex waveform can be made to 0·1% in amplitude of the fundamental at all except low audio frequencies.

(iv) *Scanning speeds* — 10, 20, 40, 100, 250 and 500 c/s. per second.

(v) *Supply* — The instrument operates from a 200 – 500 volts 50 c/s. supply. Stabilized power units are fitted.

Anisotropic Drafting Device. This device enables a graph to be re-drawn with the ordinates reduced in a constant ratio (continuously variable from 1:1 to 10:1), the abscissae remaining unaltered.

It consists of a pantograph linkage in which two points are constrained to move along the straight line parallel to the x axis.

Besides the above application, the device is of assistance when drawing ' parallel ' projections (for example ' Isometric ' projection).

Mercury Vapour Vacuum Pump. A novel type of mercury vapour vacuum pump in which the vapour condenses on an amalgamated copper surface. Its speed characteristics are by this means brought up to the level of those of oil vapour pumps. The supersonic flow in the vapour jet is demonstrated by a high frequency discharge which shows a conical shock wave produced as the jet strikes a cone.

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Smiths Electric Pilot S.E.P.1†. The S.E.P.1 is an all electric automatic pilot designed to operate from 115 volts, 400 c/s. 3-phase alternating current and requires additionally a small amount of direct current at 28 volts. Its primary function is to stabilize the aeroplane by detecting any deviation from straight and level flight and applying the required correction via the aircraft's control surfaces. The S.E.P.1 will fly at any desired attitude in pitch and will maintain a magnetic course indefinitely when used in conjunction with a suitable gyro-magnetic type compass.

Gyroscopes are used to measure the rate of movement of the aircraft about three mutually perpendicular axes and to give electric signals dependent on the rate of movement. The control surfaces are driven by servo-motors each of which is caused to run at a speed proportional to the signal from the gyroscope associated with it. A novel feature is the employment of magnetic hysteresis to develop the torque of the servo-motors. This system is called a 'rate/rate' system, since the rate at which a control surface moves is proportional to the rate of movement of the aircraft about the relevant axis. The gyro signal is fed into a valve amplifier, preceding a magnetic amplifier, whose output drives the servo motor. Each motor is fitted with a generator which develops a signal proportional to the motor speed. This signal is fed back into the amplifier in series with the gyro signal and, being of opposite phase sense to the latter, reduces the amplifier input nearly to zero. The correlation between servo rate and aircraft is thus maintained. Because the rate gyroscope cannot serve as a reference for the attitude of the aircraft, it is necessary to establish a frame of reference. This is done by sensing the direction of the earth's gravitational field by pendulums, and the direction of the horizontal component of the earth's magnetic field by the use of some form of compass. The low level signals from these devices are added to the amplifier input, and thus act as long-term monitors.

The three gyroscopes and the two pendulums are mounted on a platform gim-

balled so that it may be rotated in pitch and roll. The system will maintain this platform level so that if it be moved relative to the aircraft, it is the aircraft which will move, and not the platform. It is therefore possible to change the aircraft's pitch attitude by running a motor which causes the platform to rotate, relative to the aircraft, in pitch.

Turns are made by rotating the platform in roll, thus causing the aircraft to bank, and at the same time injecting a signal proportional to the desired rate of turn into the rudder channel. This signal is of such magnitude that, when the aircraft is making a correctly co-ordinated turn, the signal is equal, and of opposite sign, to that given by the rate-of-yaw gyroscope. To compensate for errors such as would be caused by changes of airspeed, a pendulum is so mounted as to measure the angle of sideslip, and thus inject a signal into the rudder channel to reduce sideslip.

Several of the components are arranged for demonstration, among which the following are particularly worthy of note :

The Rate-Gyro. Attention is drawn to the novel spring suspension, whereby the unreliable gimbal bearing of conventional gyroscopes is avoided. Damping is provided by a geared copper disc in the field of a permanent magnet and an inductive signal pick-off is employed. Thus the gyro is free from friction and great threshold sensitivity is secured. The gyro measures rate of rotation over a range of 1,000/1.

The Servo System. A 'set-able' potentiometer provides a signal to take the place of the gyro signal. This signal is backed off by a speed signal from an asynchronous generator on the same shaft as the hysteresis motor. The A.C. misalignment signal after amplification and demodulation is fed to a single stage magnetic amplifier which reversibly controls the field of the hysteresis motor. Thus the speed of the servomotor is accurately controlled by the demand signal.

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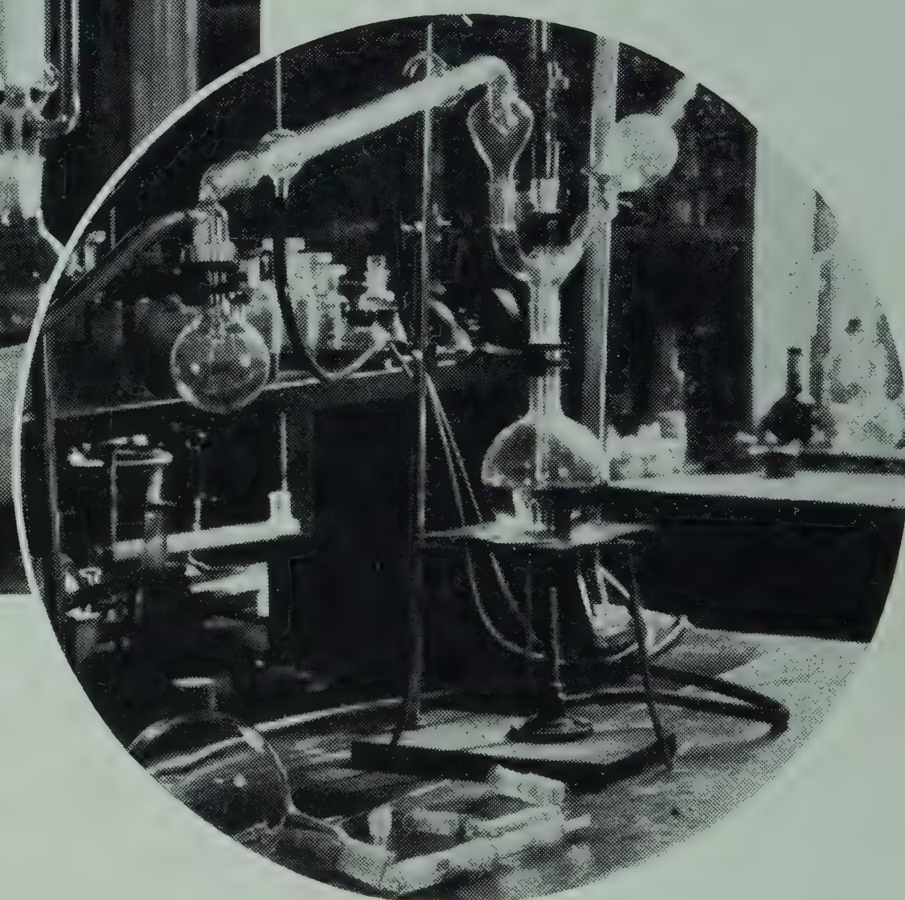

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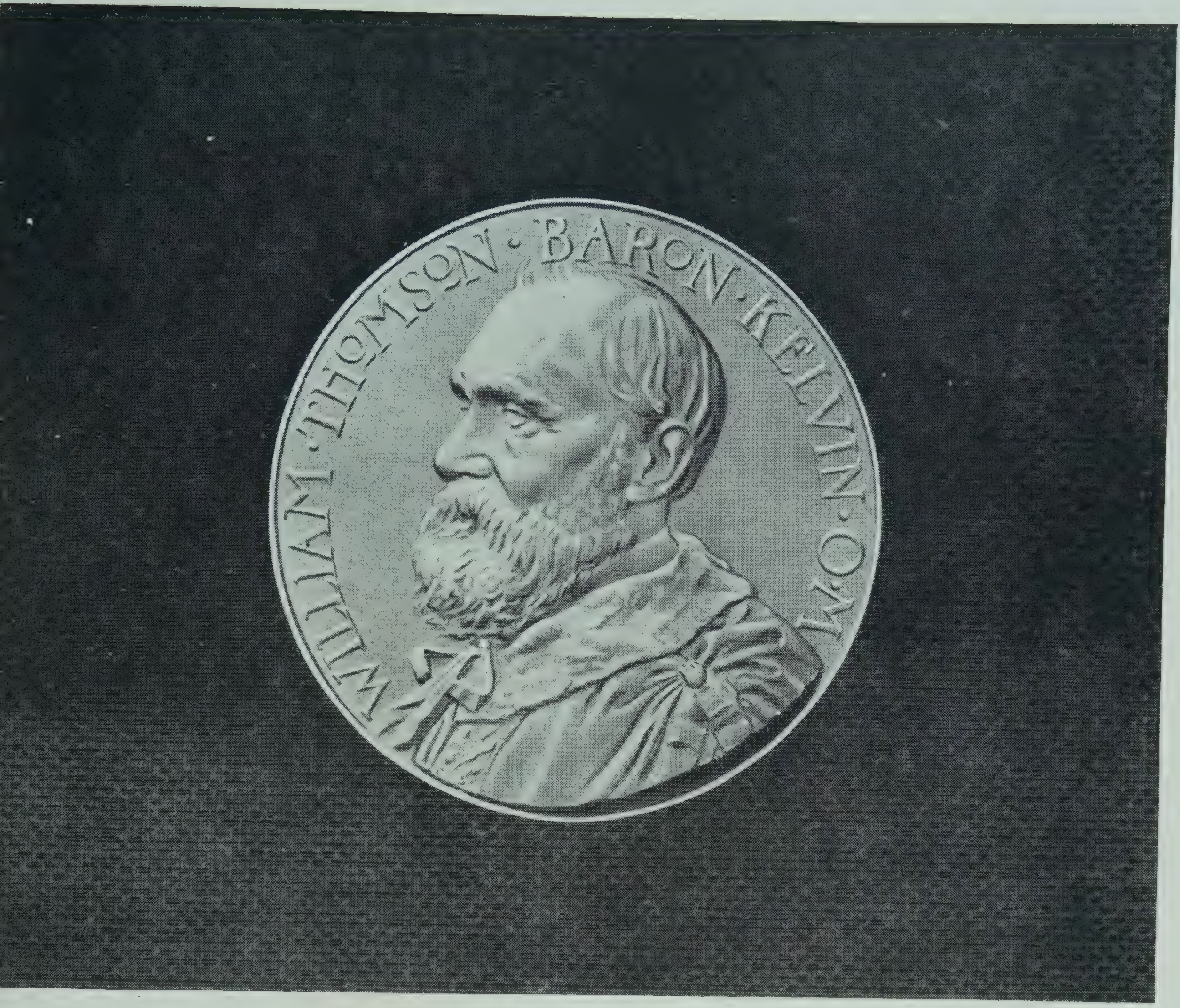

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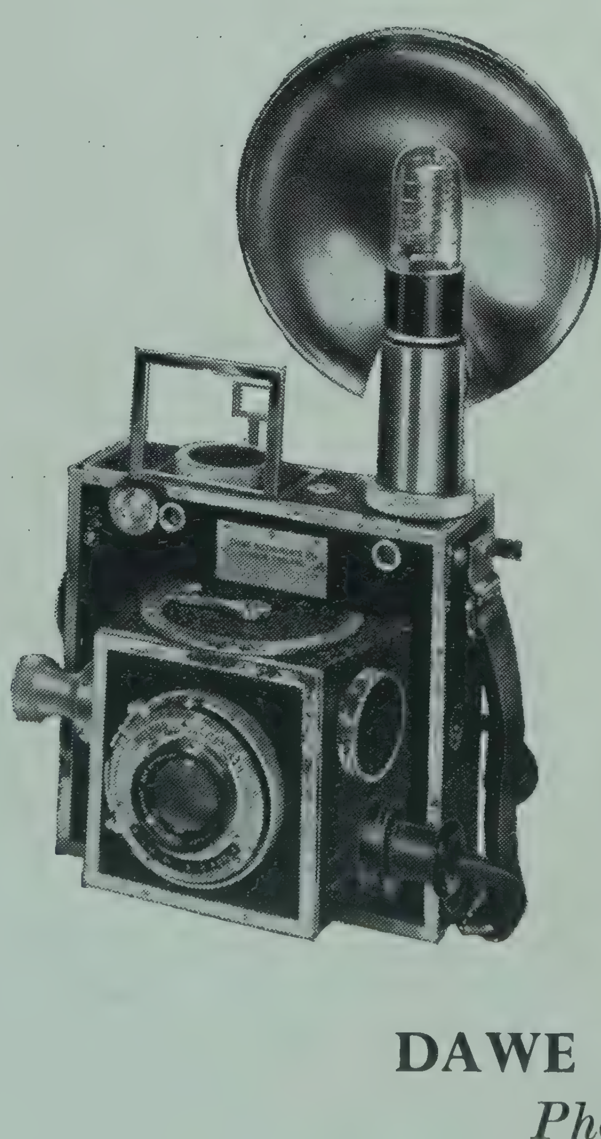

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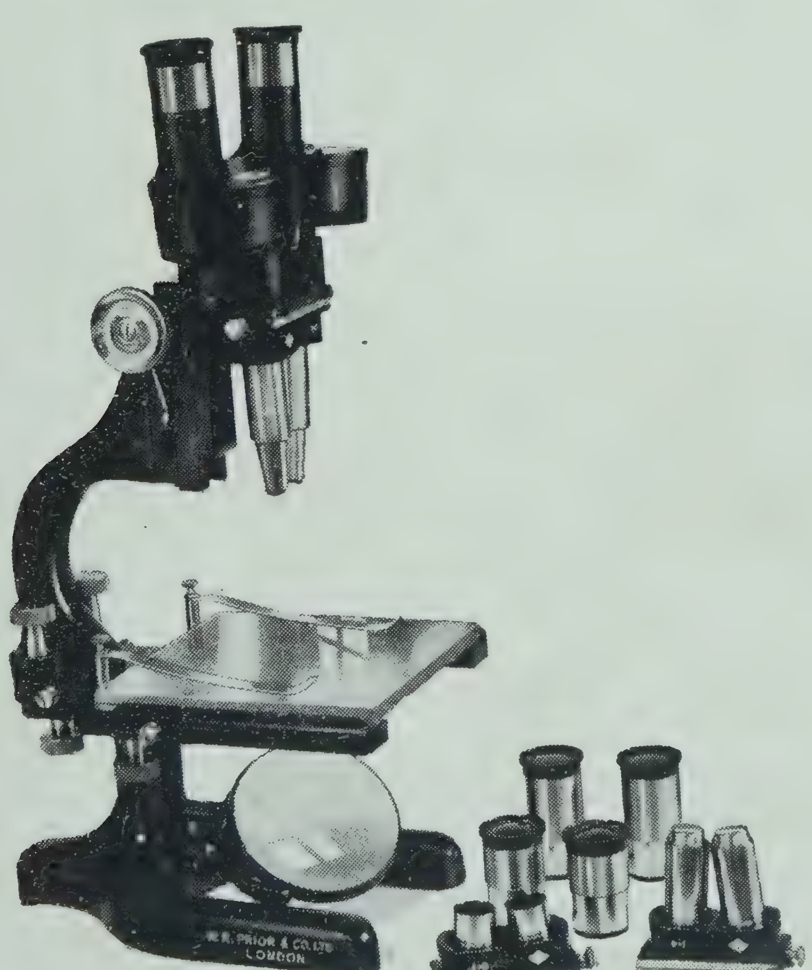

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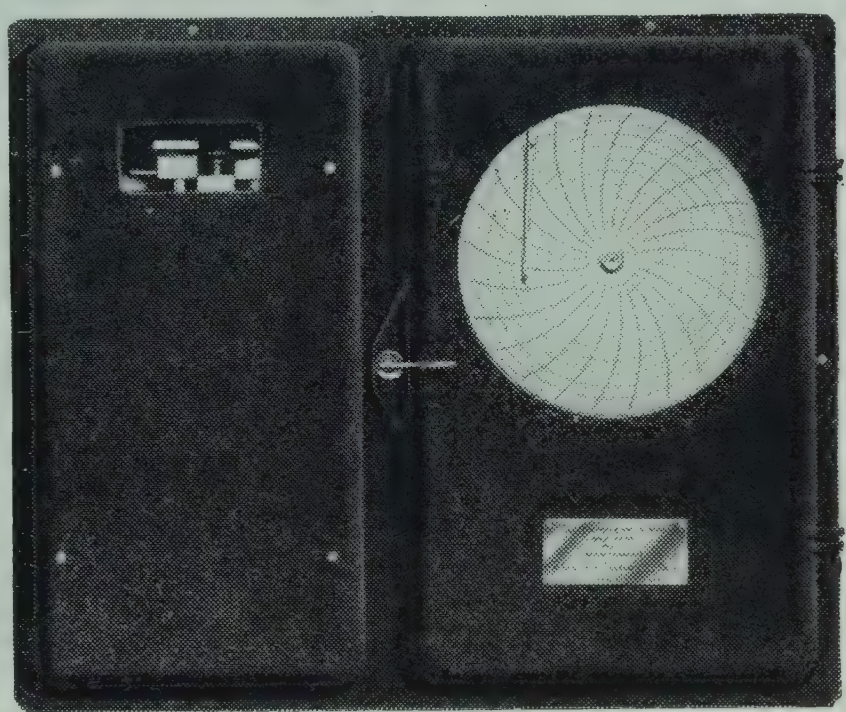

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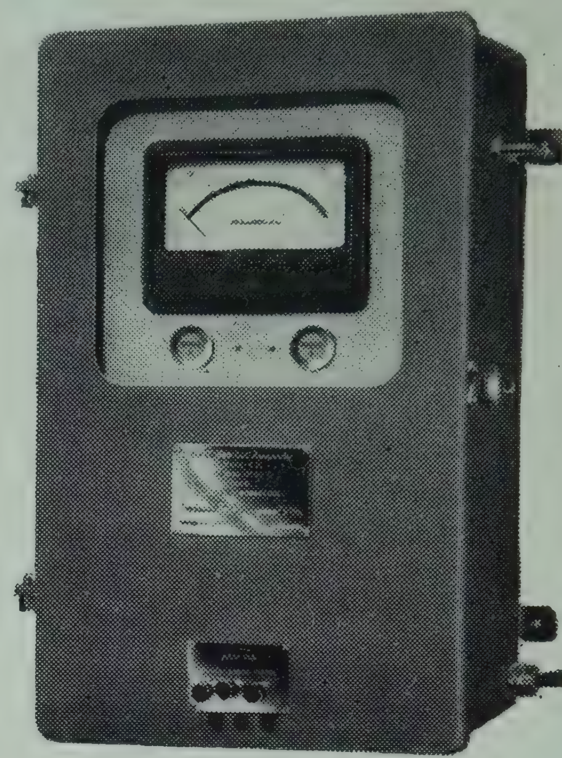

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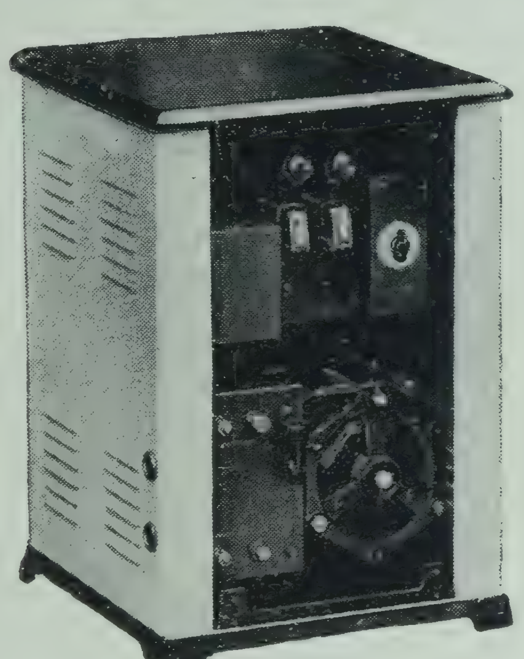

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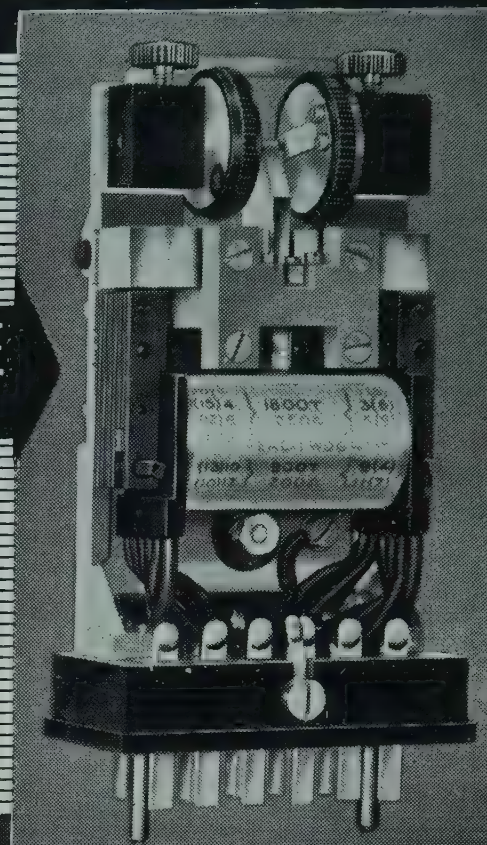

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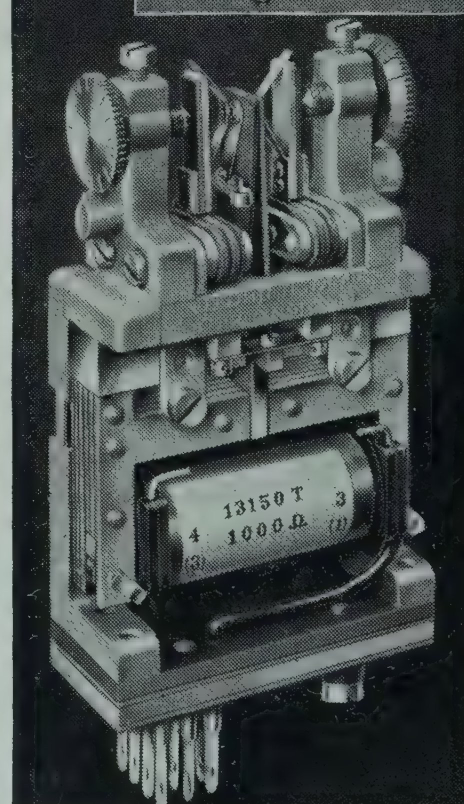

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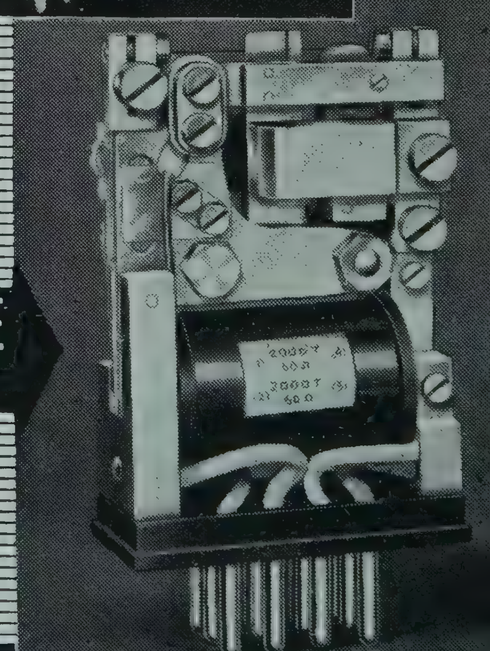

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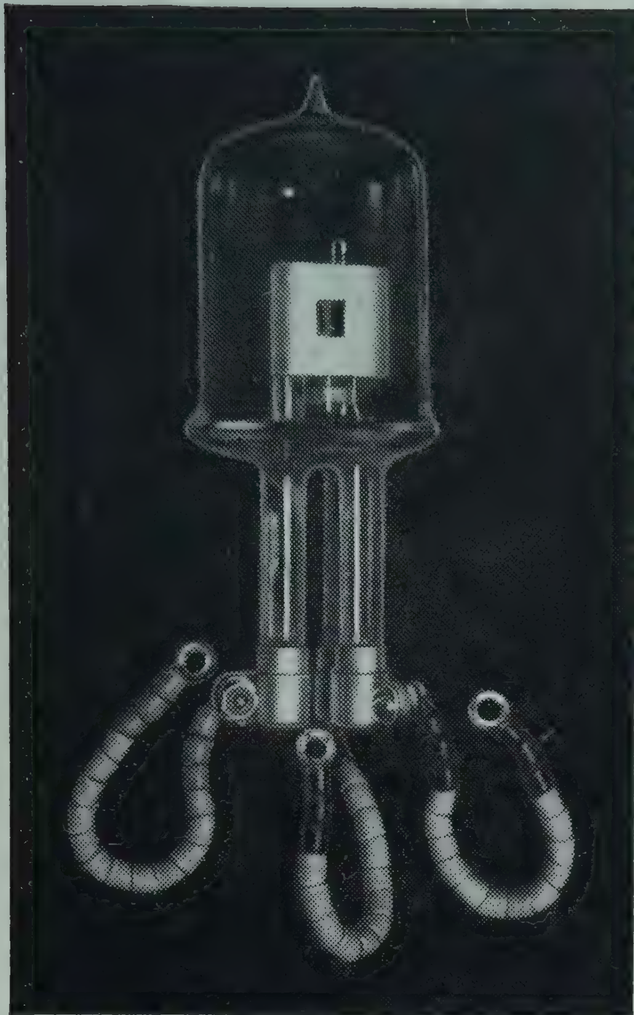

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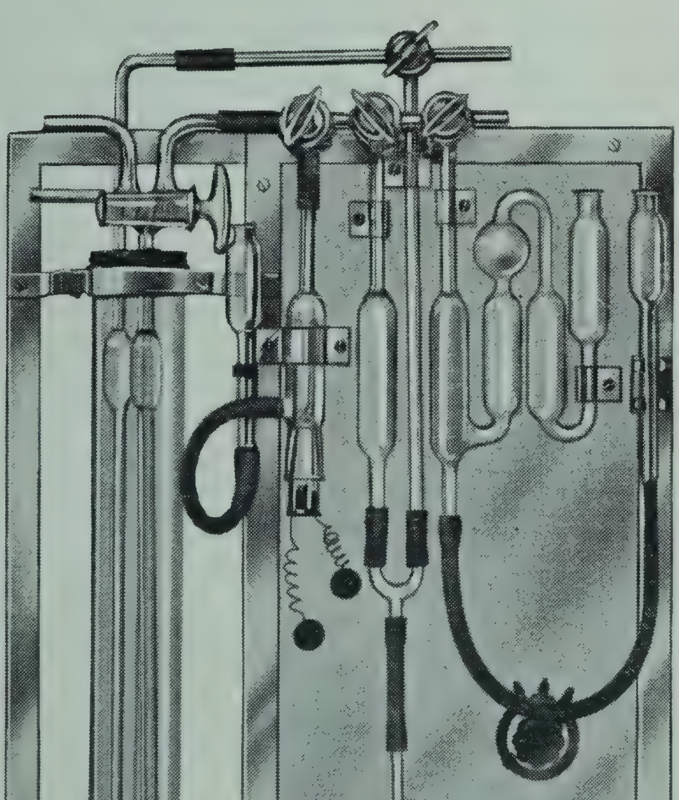

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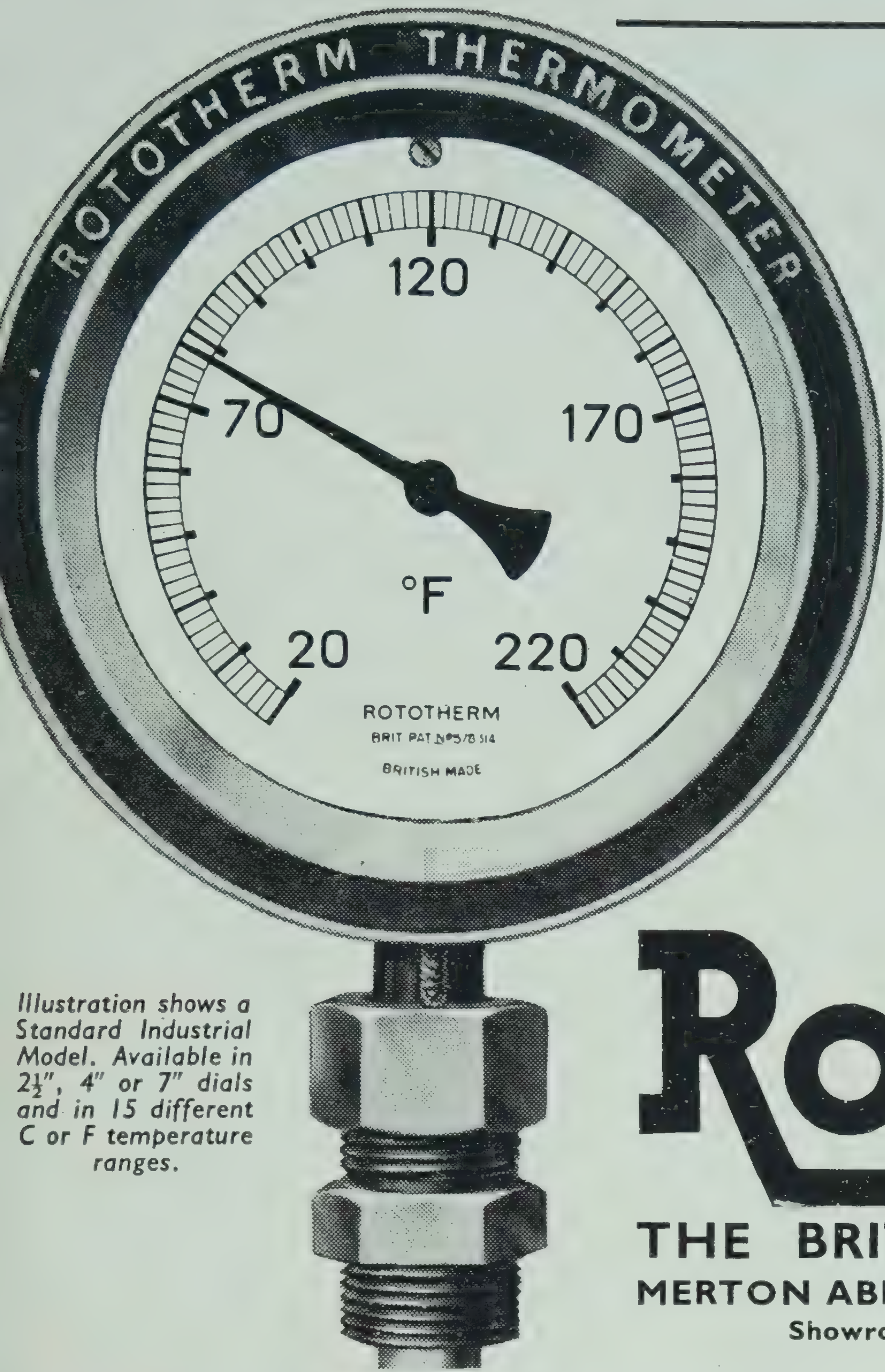

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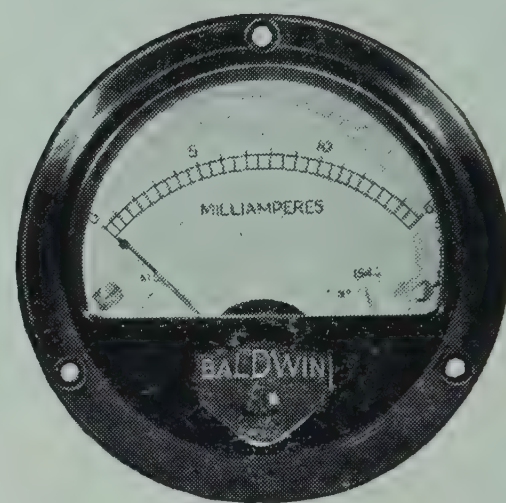

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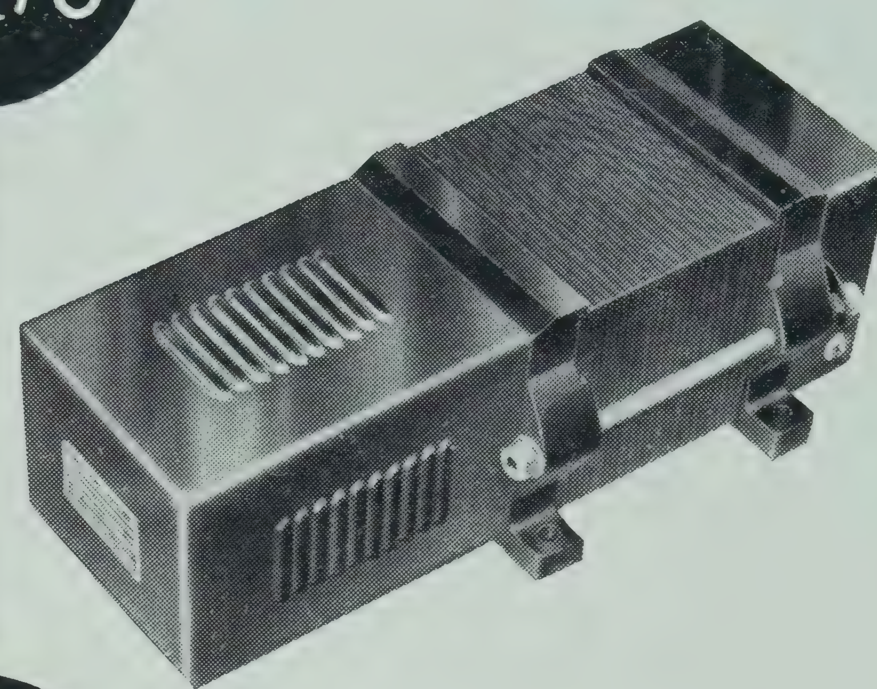

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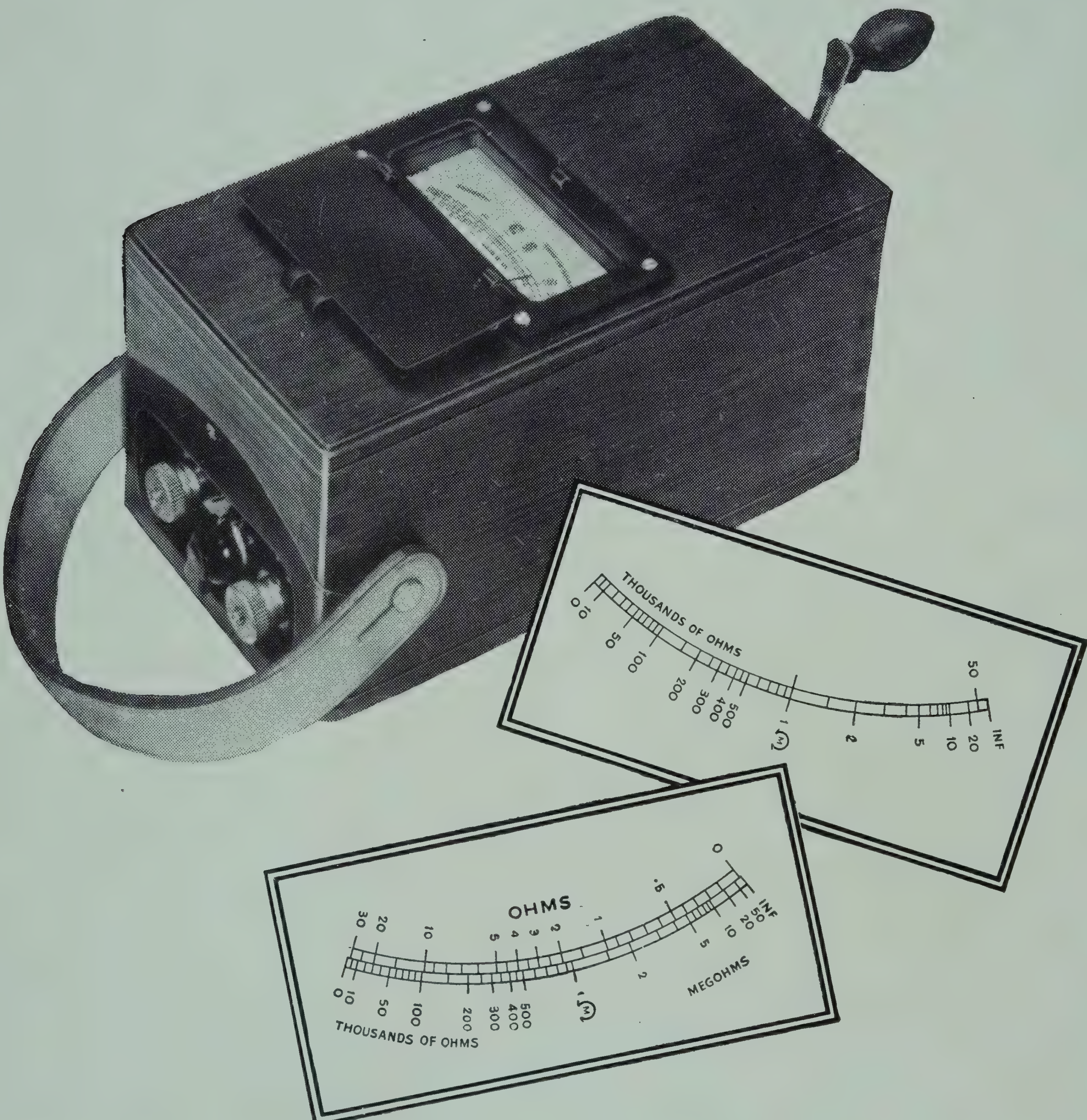
STAND NO. 73

THE "MAJOR" INSULATION TESTER



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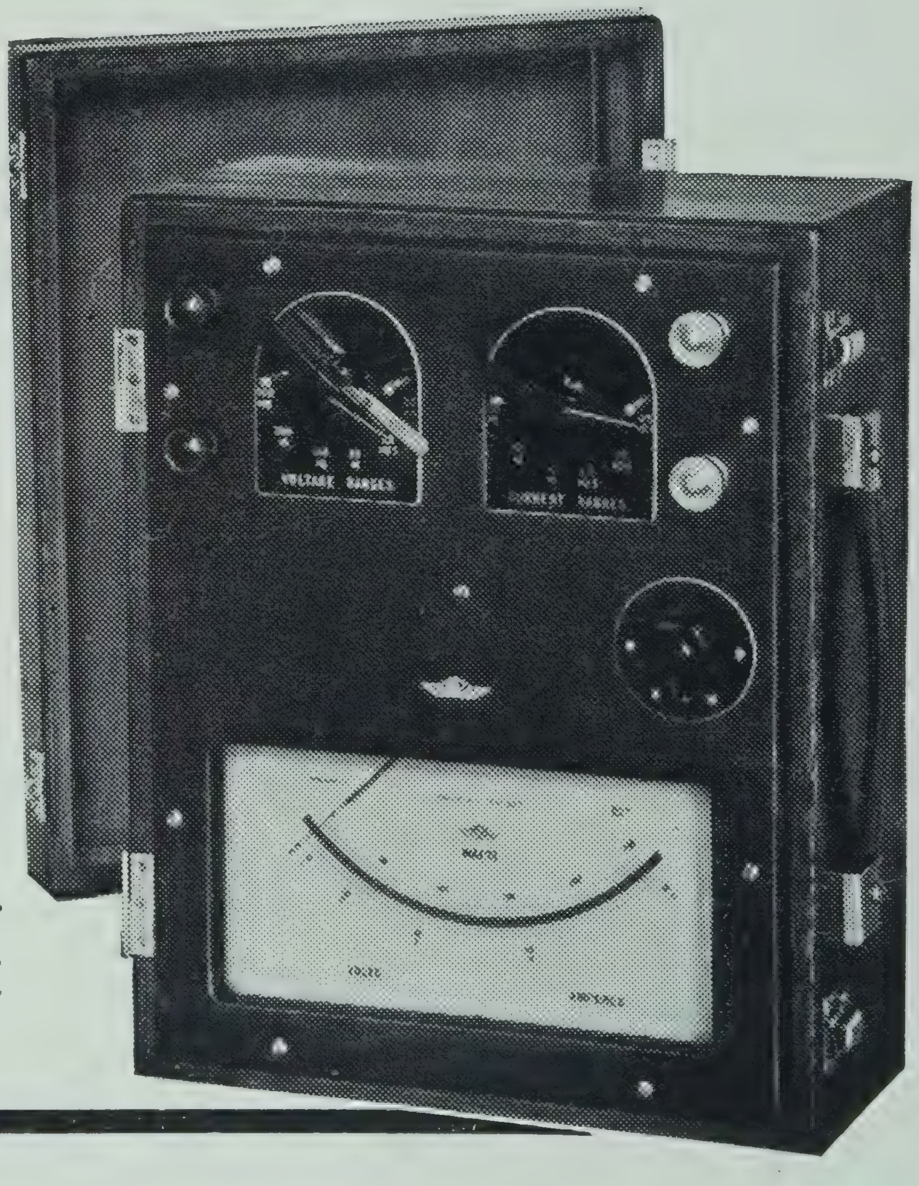

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An Introduction

AT THIS EXHIBITION some of the work of the Fielden Organization is shown, for the first time, to a large company of Physicists and Engineers. A brief statement of aims and achievement is therefore opportune.

The group, which comprises members who were variously concerned with developments in electronics during the war, has turned to Industrial Instrumentation - mainly basing its practice upon minute changes in electrical capacitance. The belief was held that pursuit of this previously neglected line of research provided enormous scope for entirely new products and, in three years, the Fielden Organization has contributed six new instruments of considerable importance to Industry, none of which fringe on existing types. Several more are nearing the commercial stage. The best known example is, perhaps, the Fielden " Drimeter " Moisture Content Indicator for yarns and fabrics, more than a thousand (with and without automatic machine-control) now being in operation in British mills and many more abroad.

The demand for the six instruments made commercially available since 1946 is reflected in the building of a new factory at Wythenshawe, Manchester, with adequate production facilities and an ample laboratory.

The Company has also established associates in the U.S.A. and Australia to attend to sales and service on those continents.

This progress has been much assisted by the interest of a small circle of Industrialists, aware of the possibilities of carefully planned physical measurement and control in their plants. With growth of this circle of collaboration the Fielden Organization is confident of making a significant contribution to the successful development of this vital factor in modern research and production technique.

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Governing Director: John E. Fielden, M.Sc.(Tech.), A.M.I.E.E.

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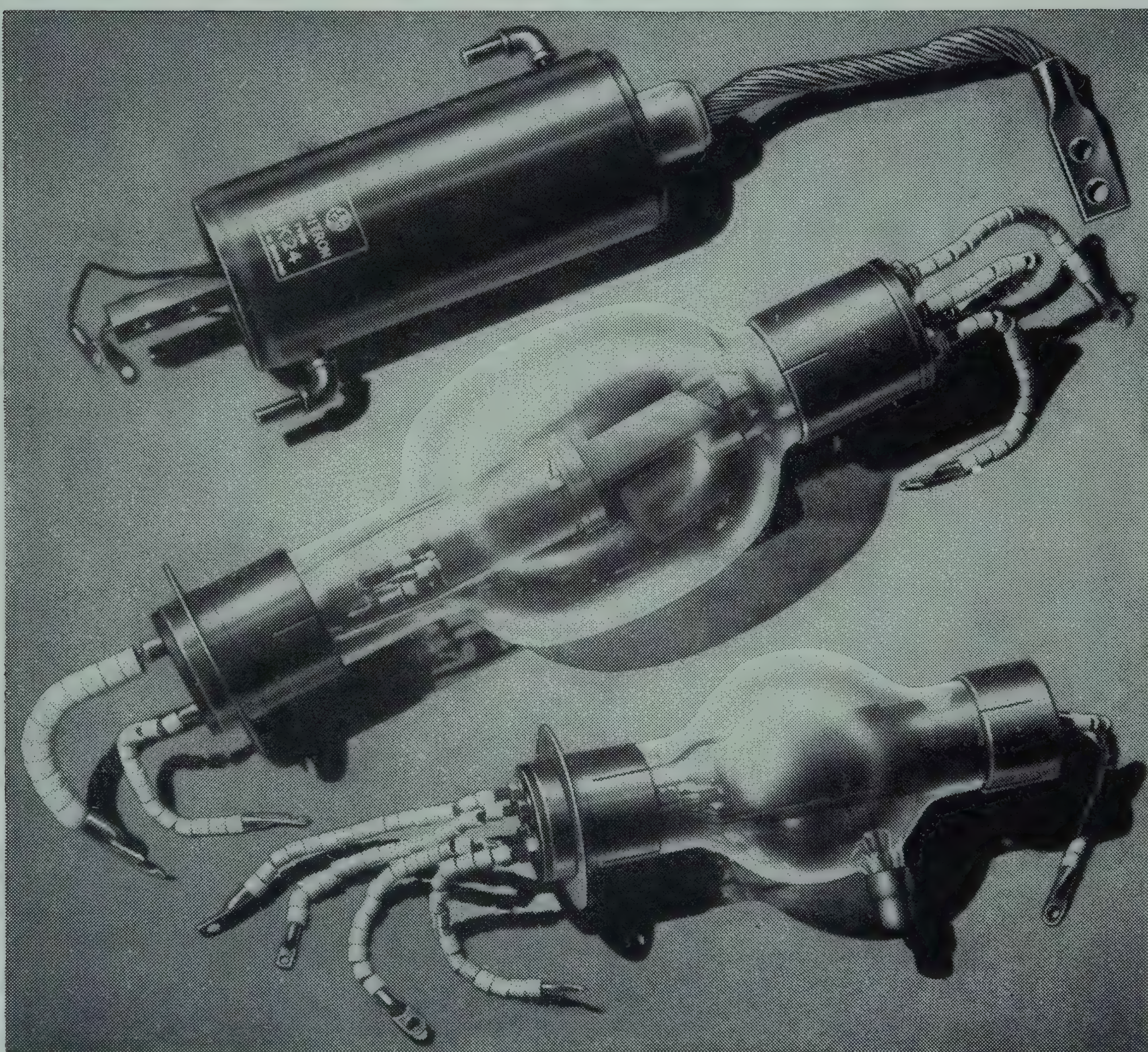

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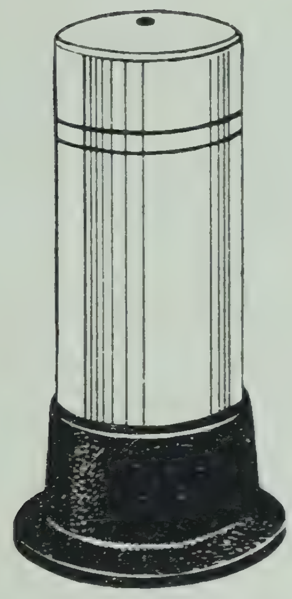

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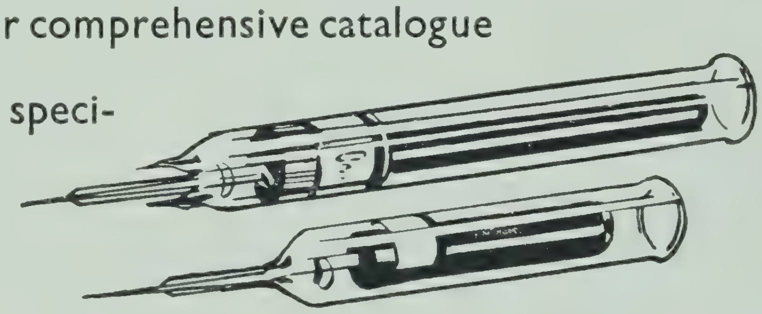

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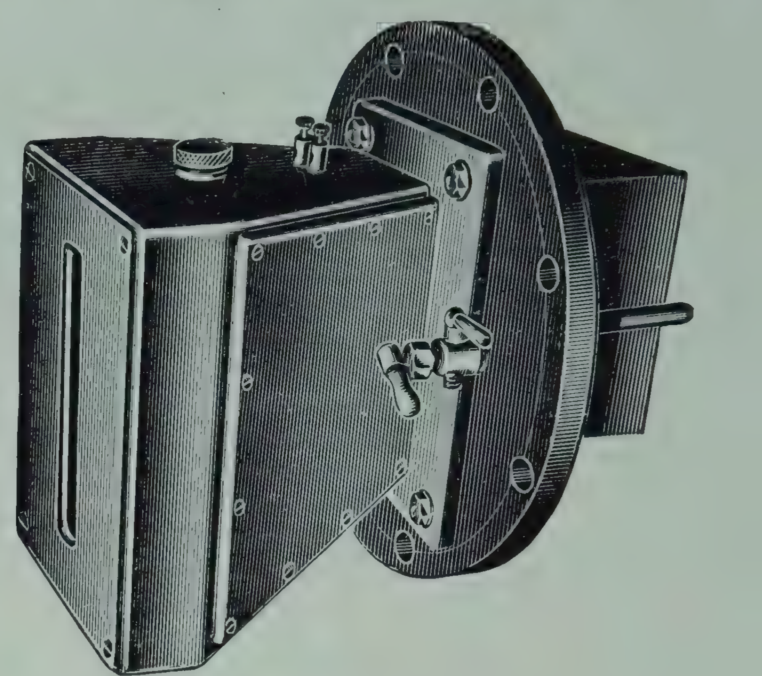

This instrument is mounted directly into the vacuum pan, and the sugar concentration may be determined at any time by observing the border line of total reflection.
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L.625/P Flex Plug shown on right
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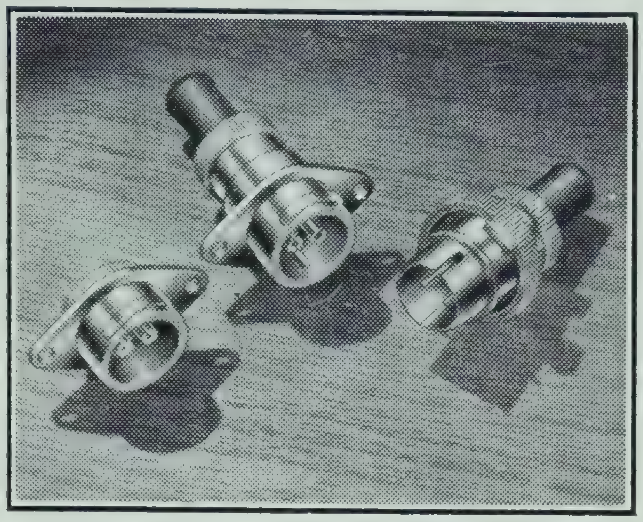

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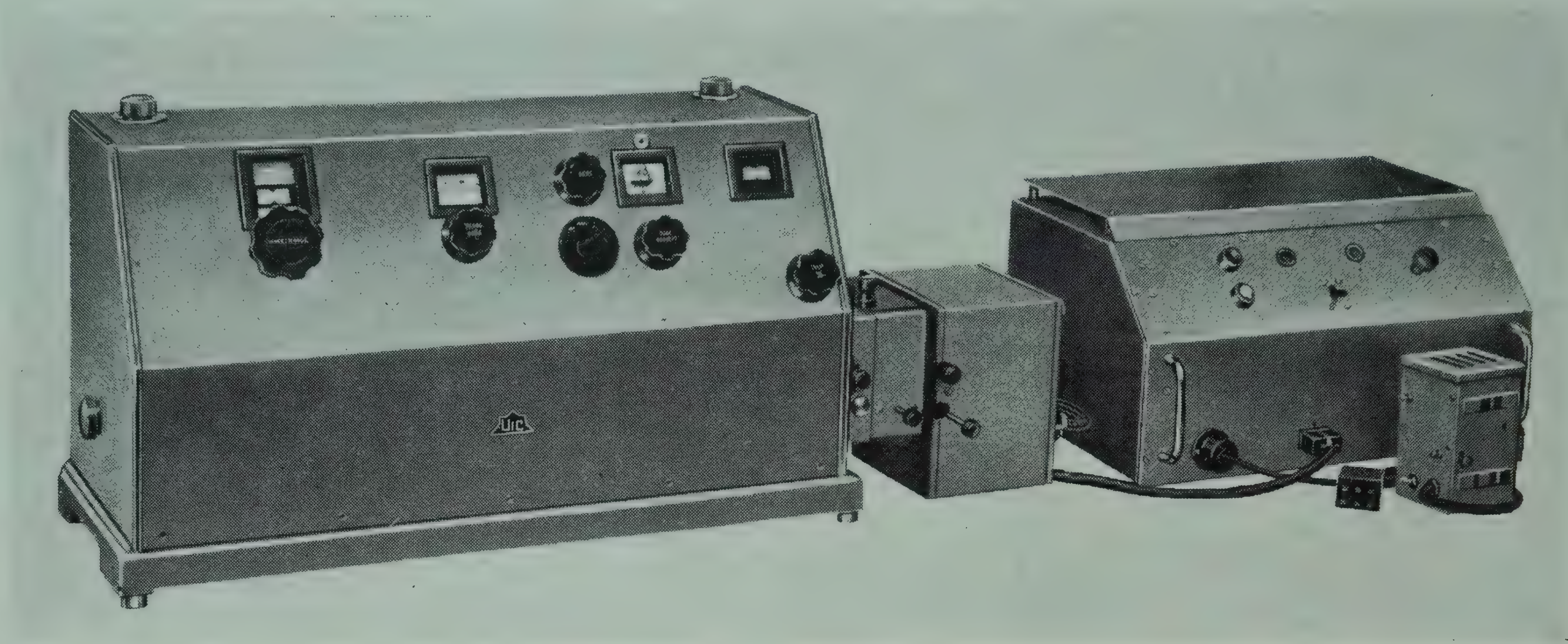

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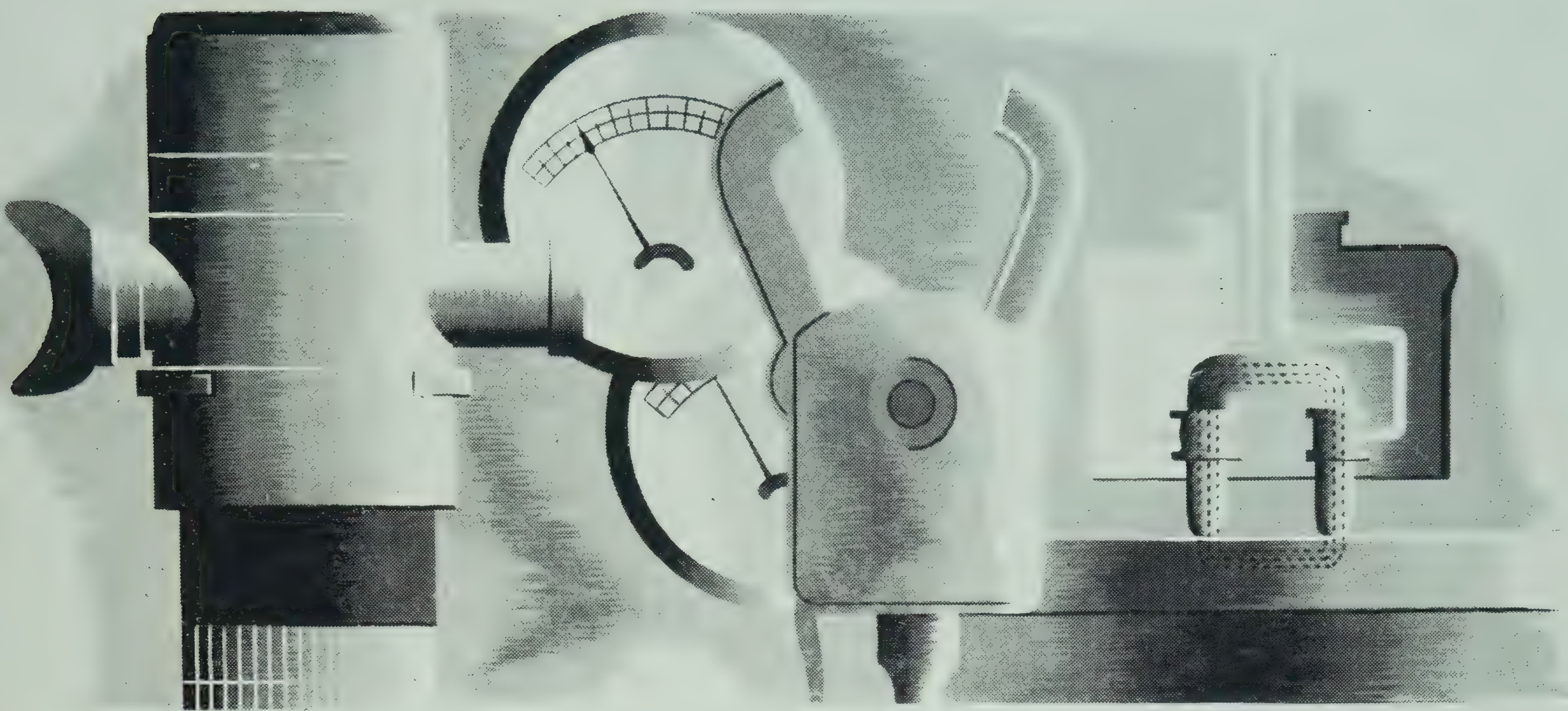

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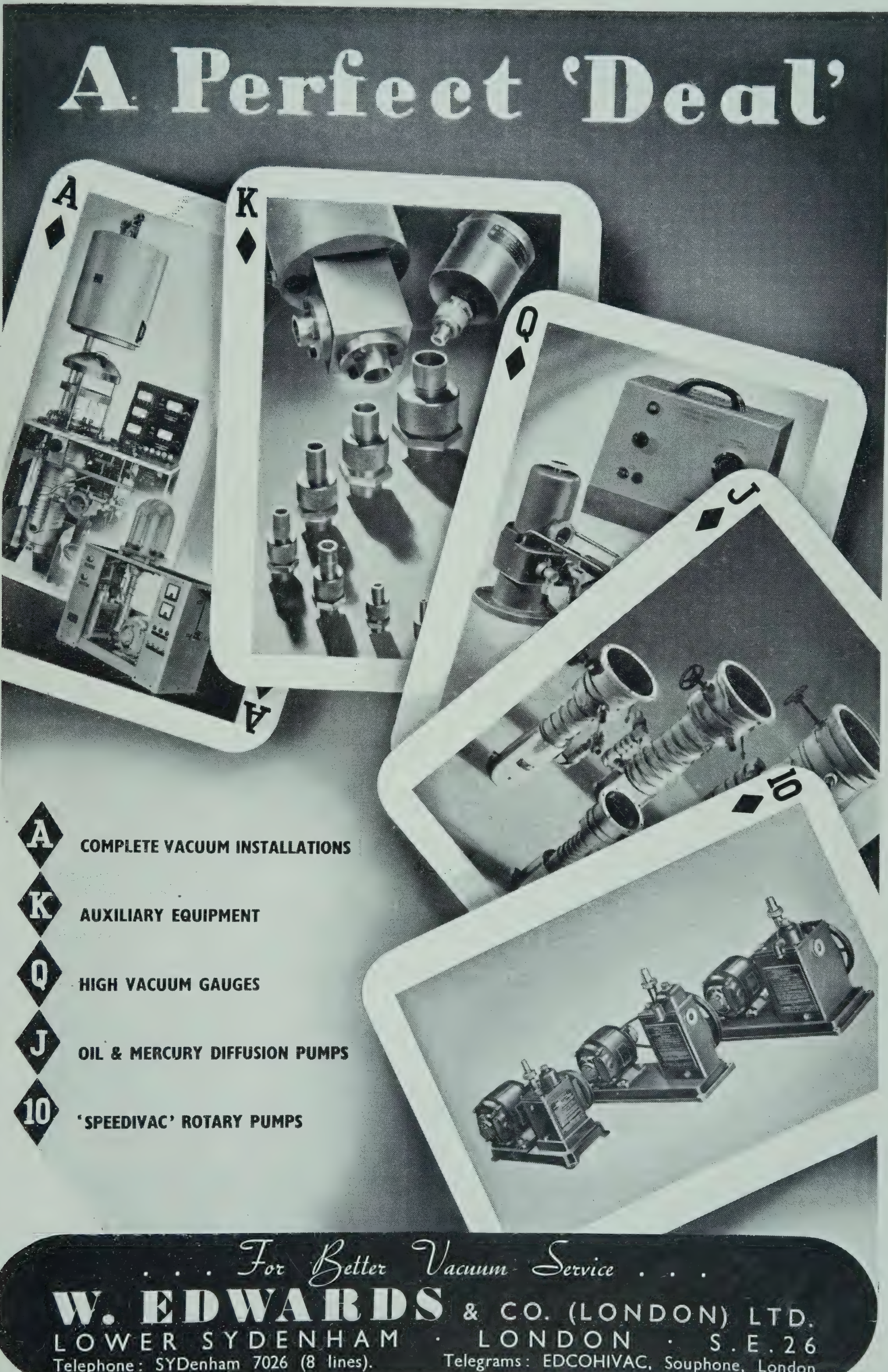
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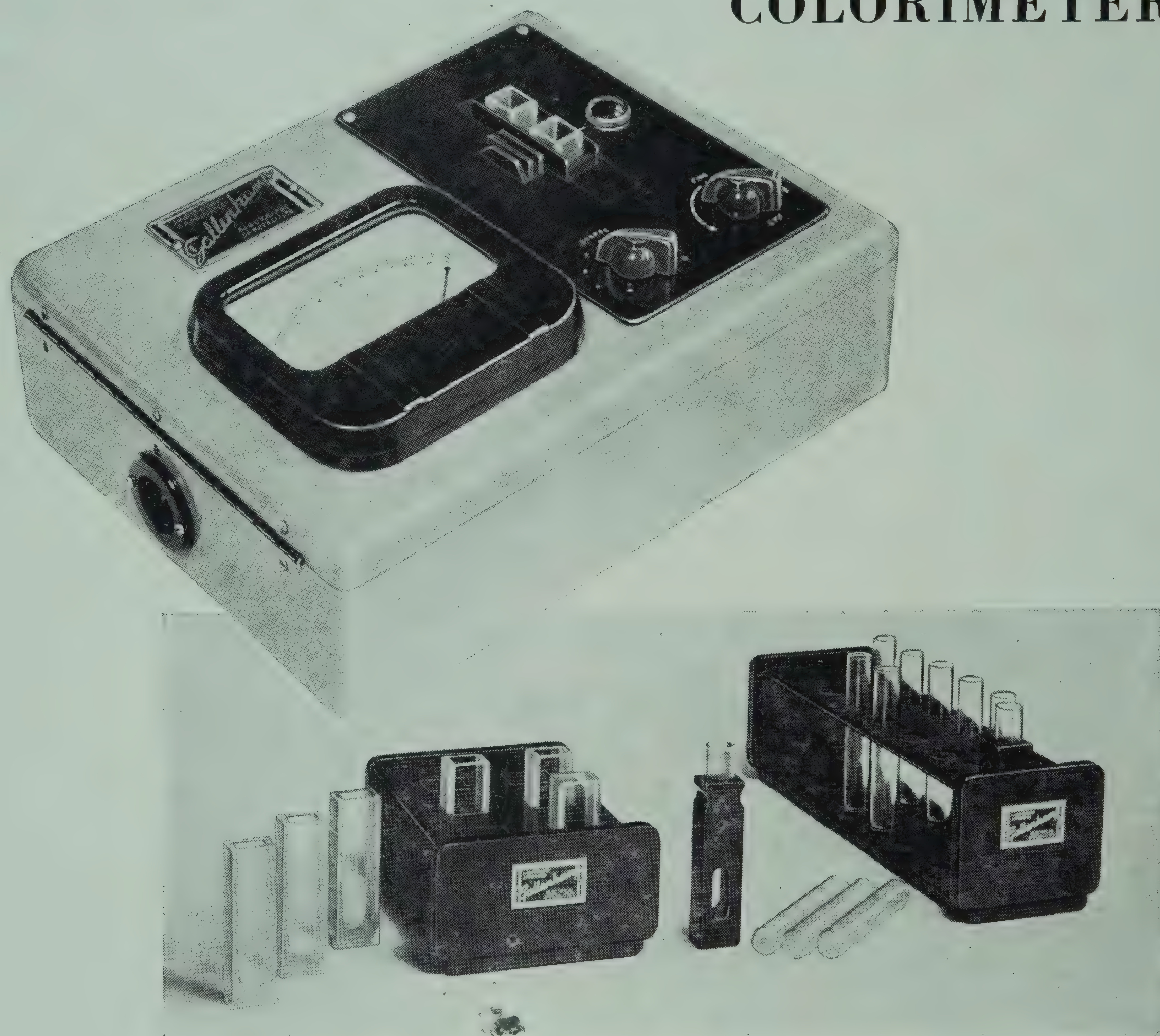

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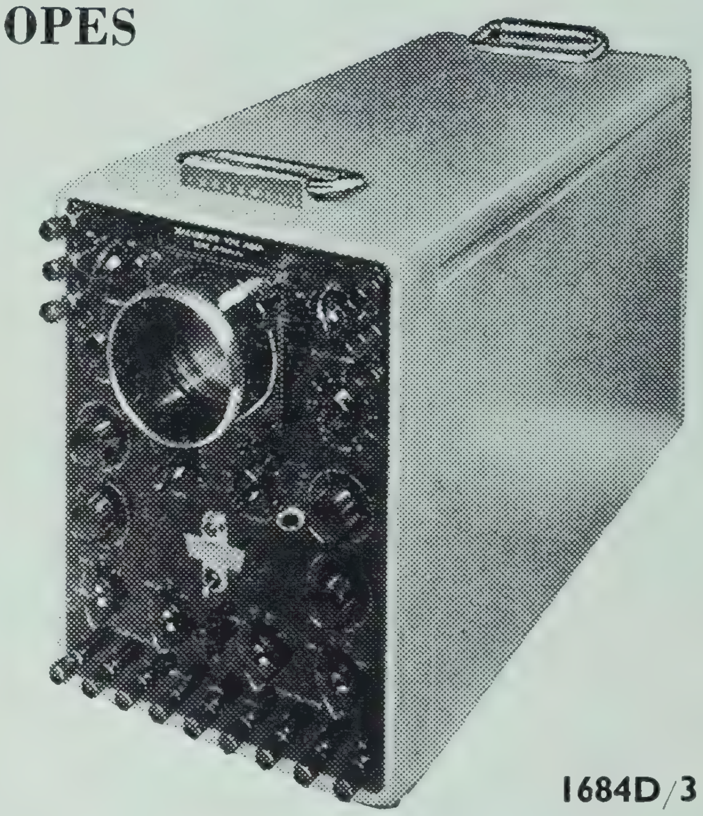

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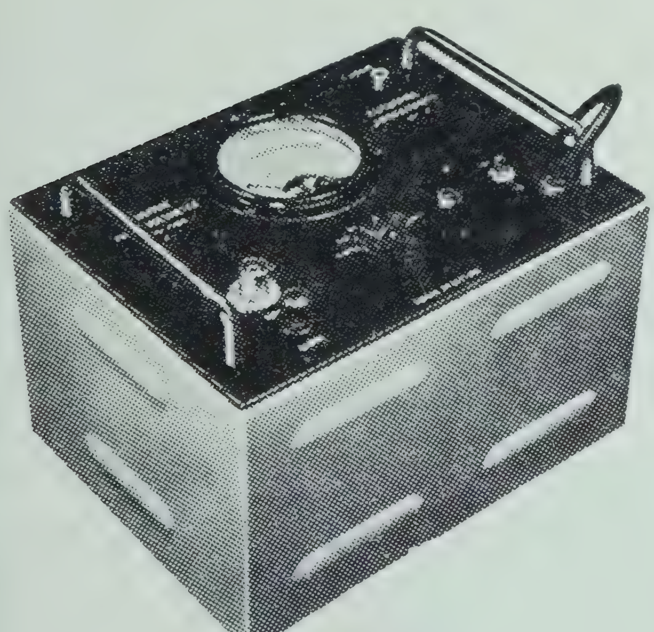

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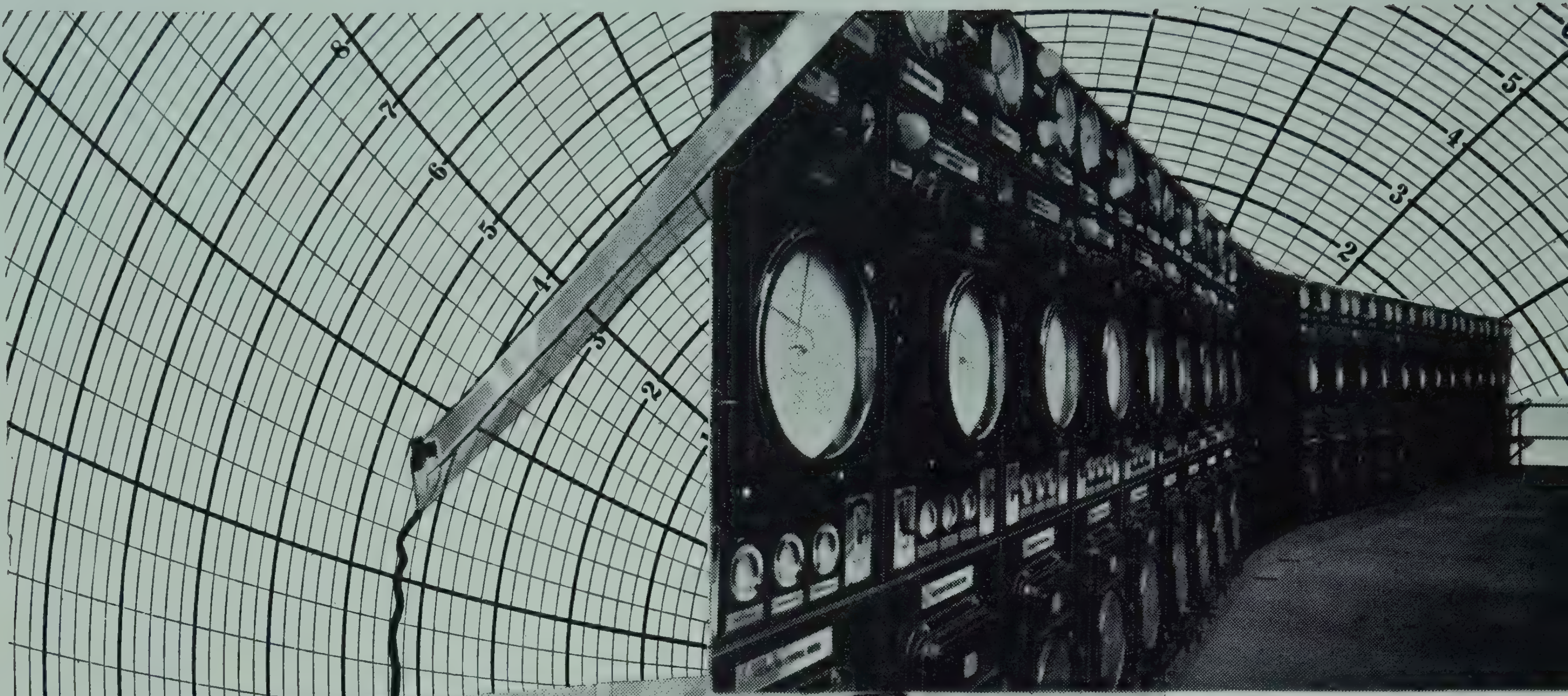
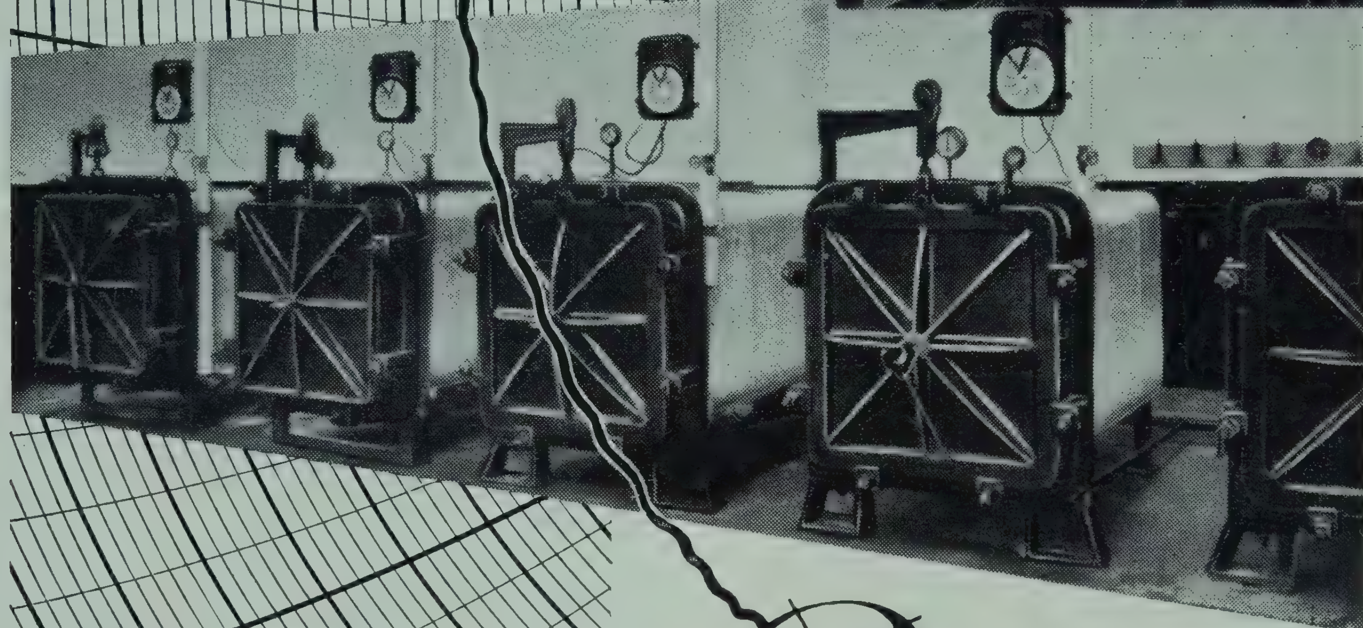
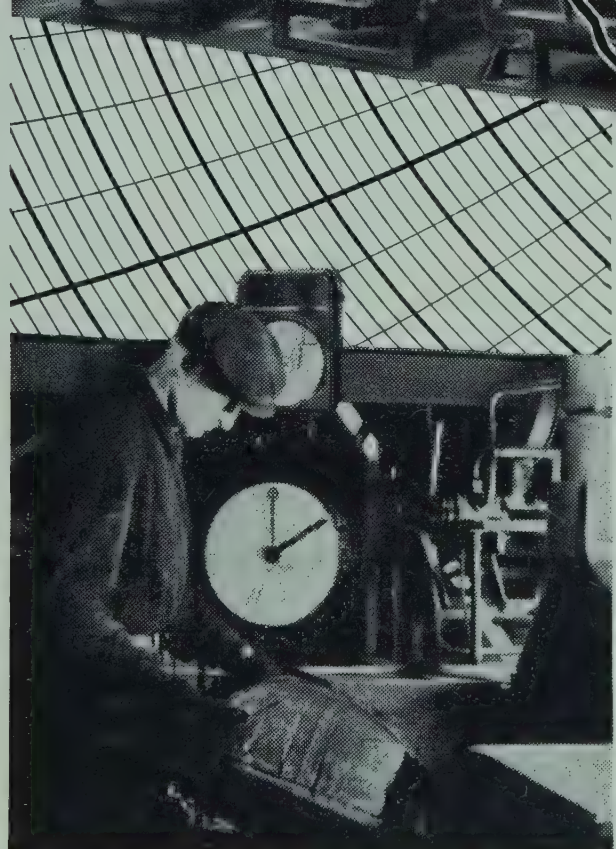


A Bristol's Co-ordinated Control system regulating the time-temperature schedule of tyre manufacture. Photograph by courtesy of Messrs. The Dunlop Rubber Co.



A Bristol's Retort Control and Recording System for food canning at the Vauxhall works of Messrs. Brand & Co. by whose courtesy this photograph is reproduced.



A combination of Pyromaster and Process Signal indicator used on a Bridge Banbury Mixer to ensure consistent mixing and compounding of rubber and plastics. Photograph by courtesy of Messrs. Henley's Tyre & Rubber Co.

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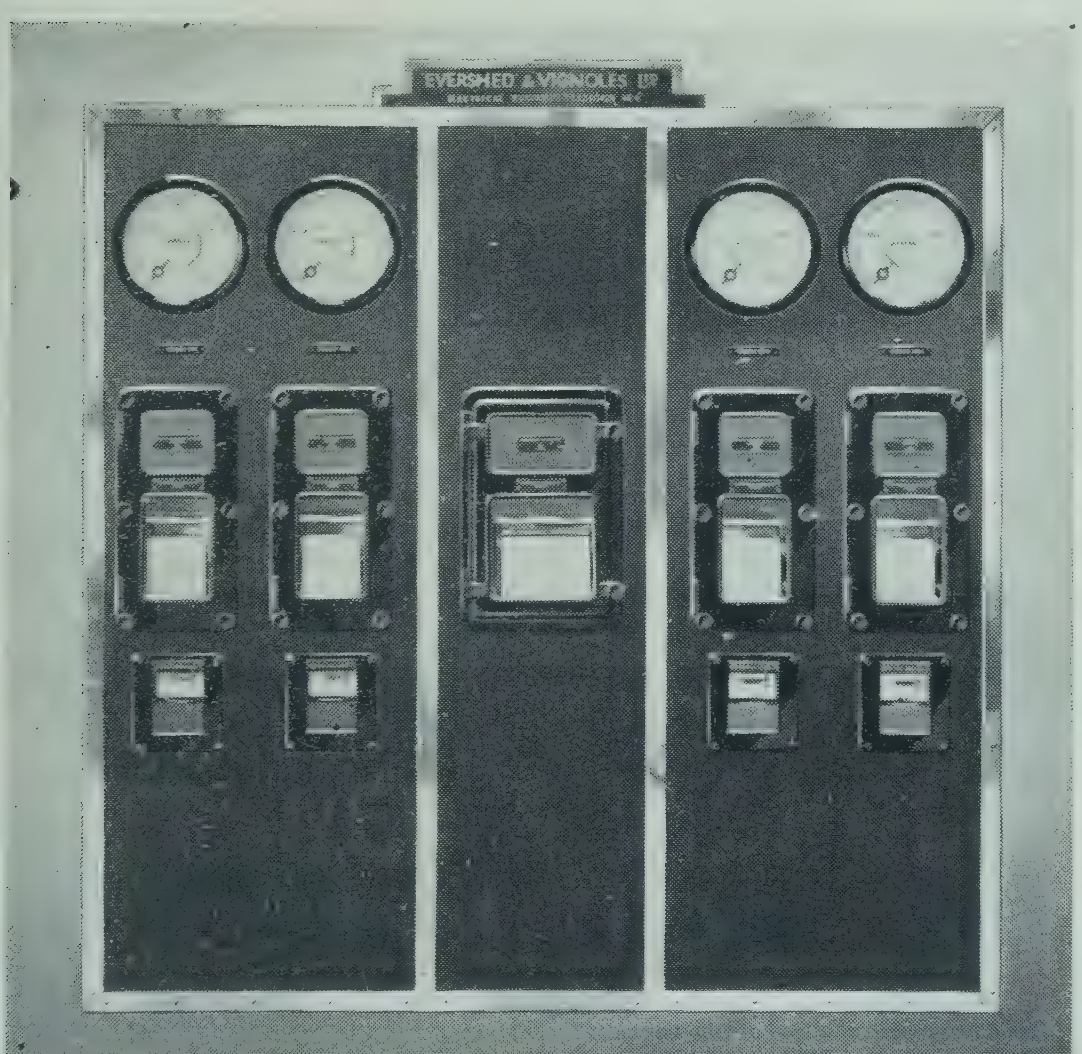

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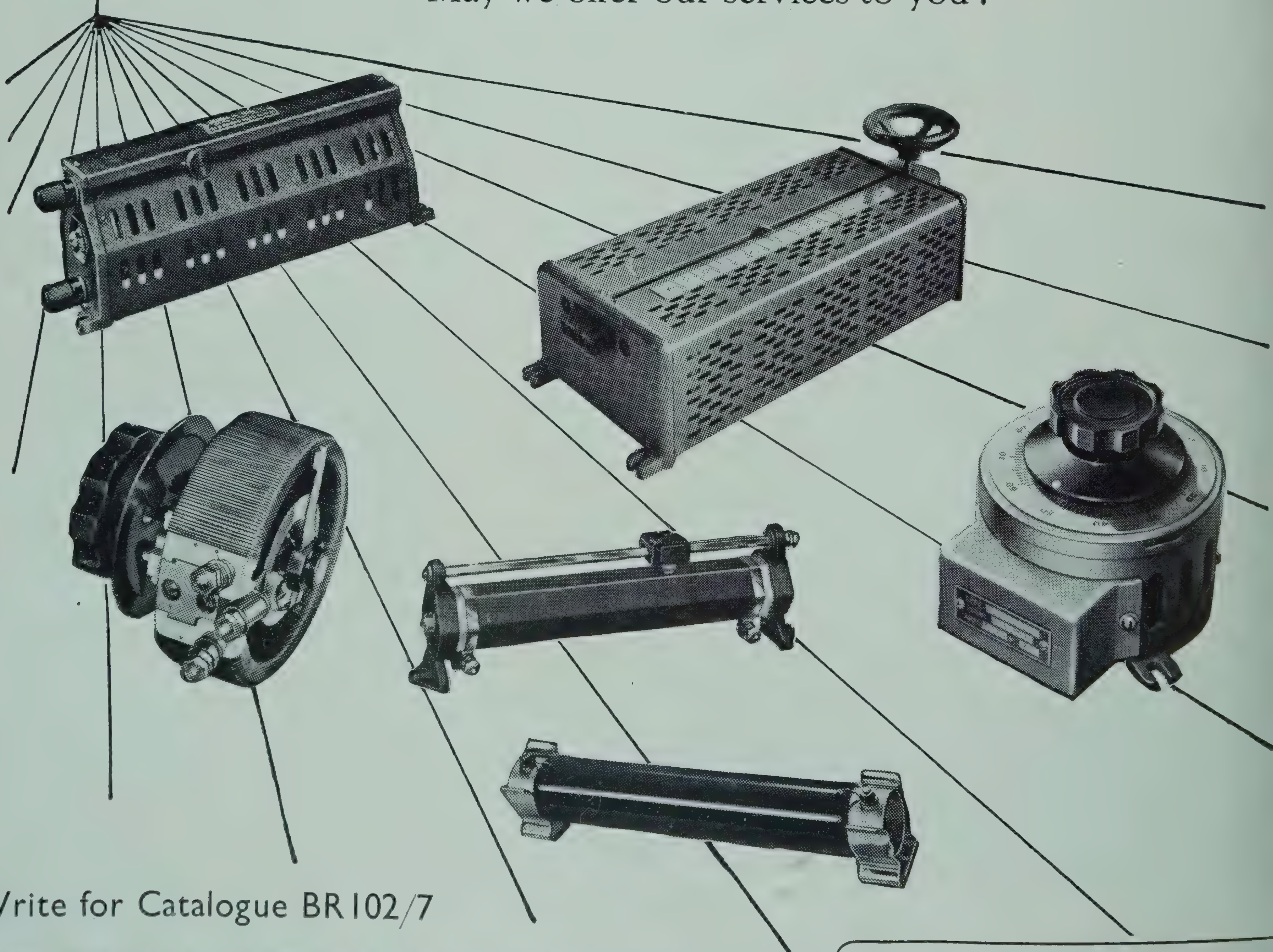

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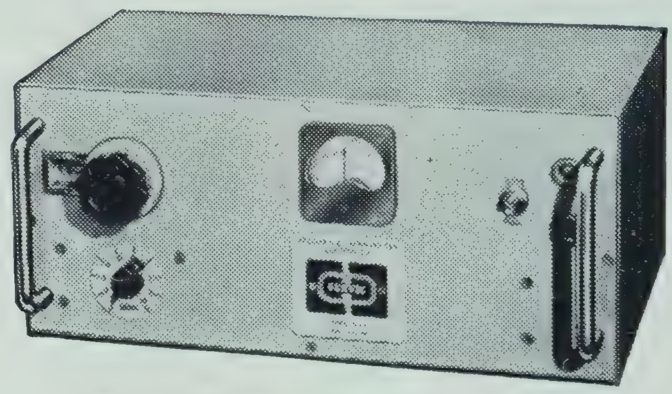

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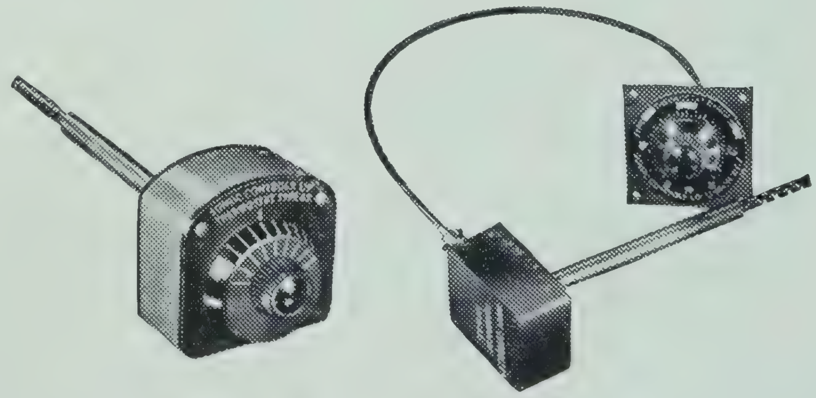

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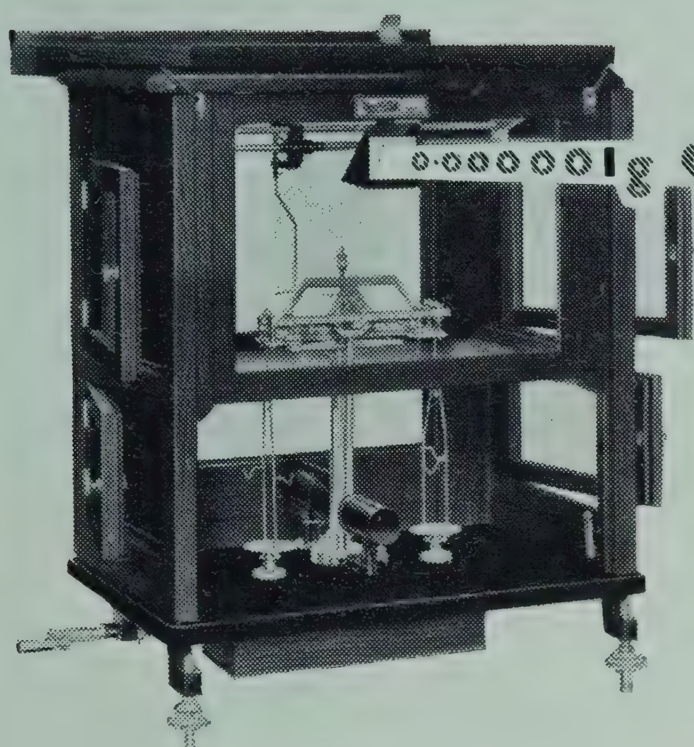

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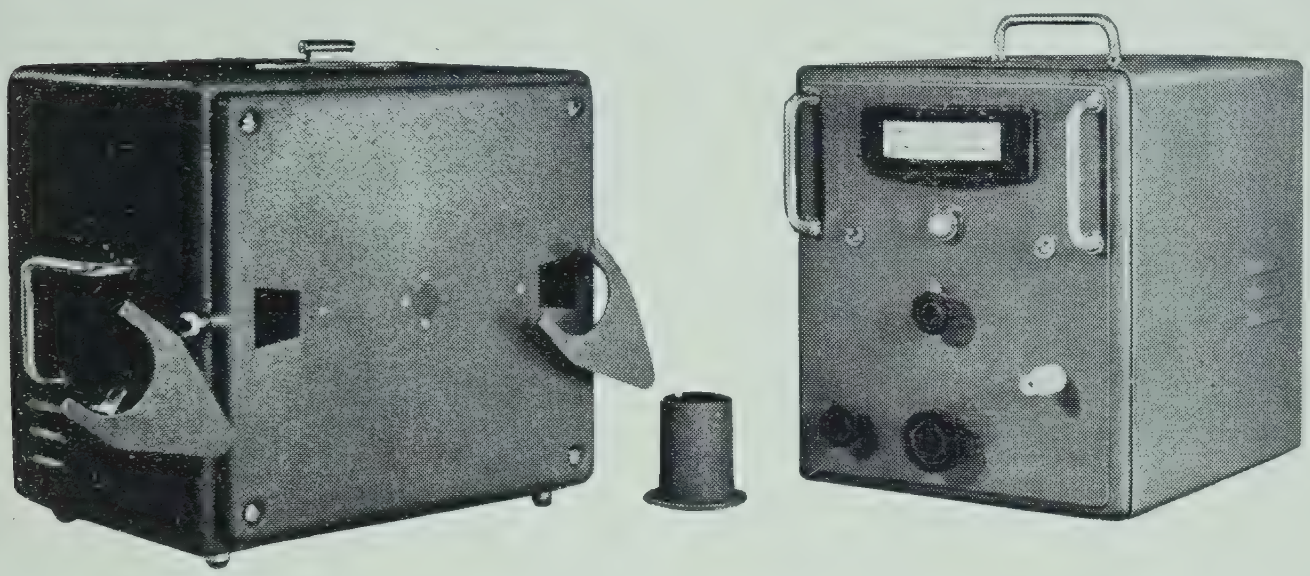

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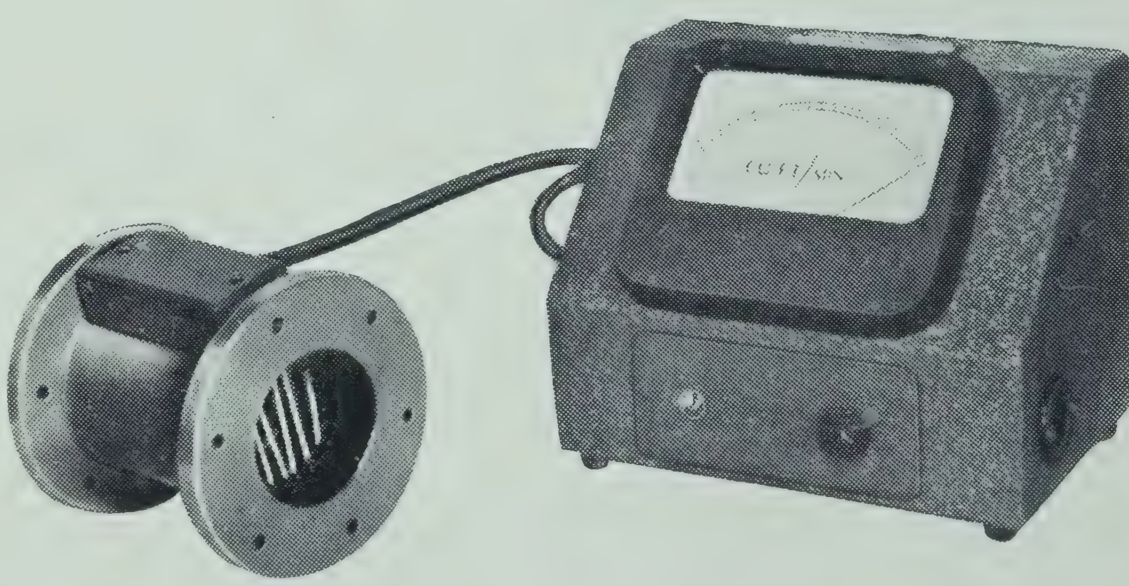

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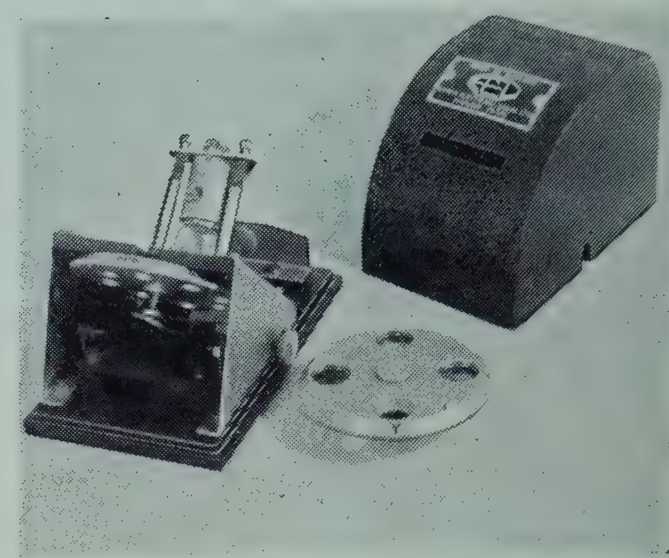

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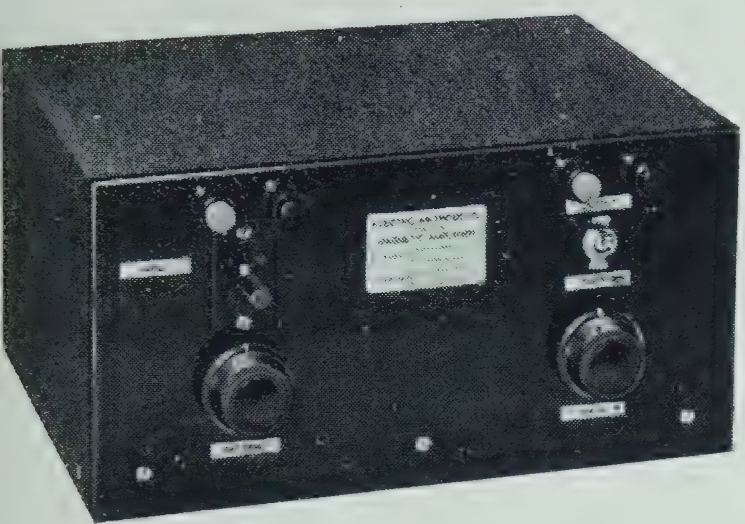

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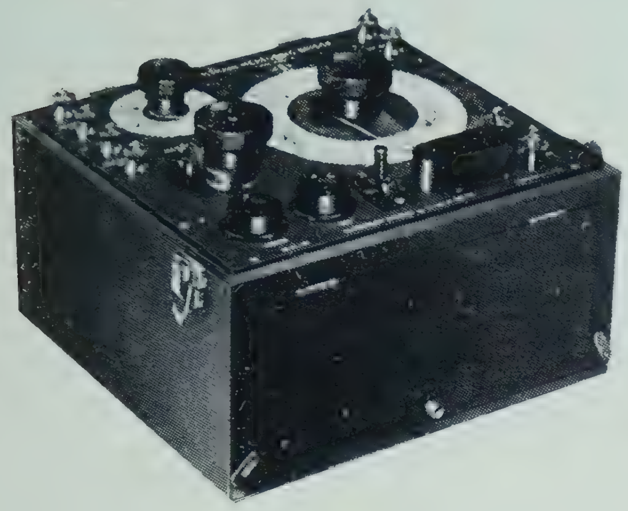

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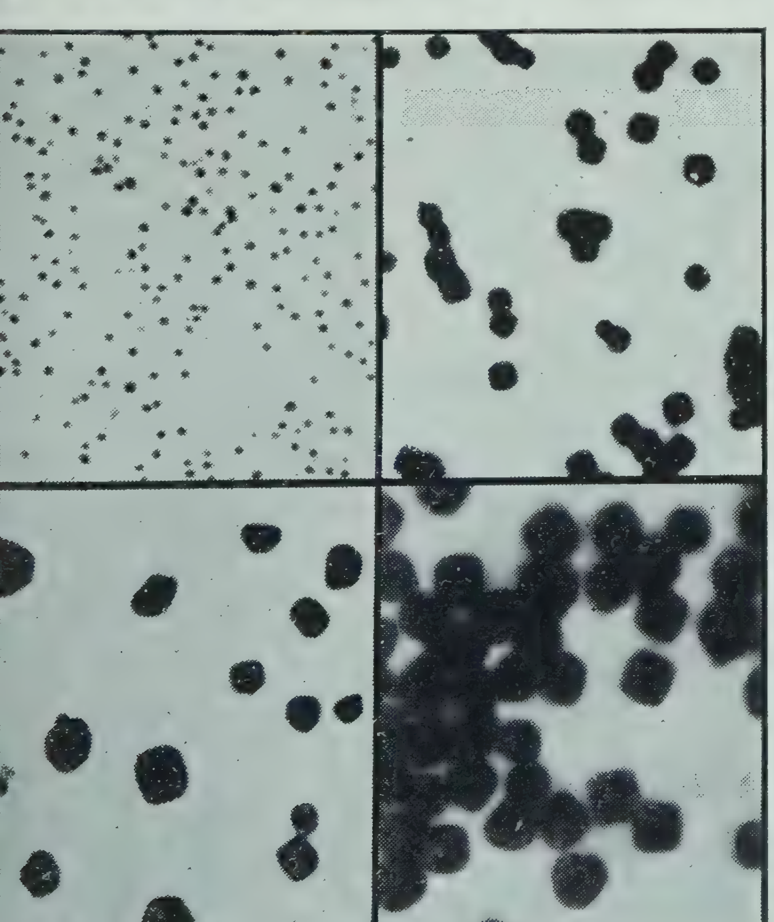

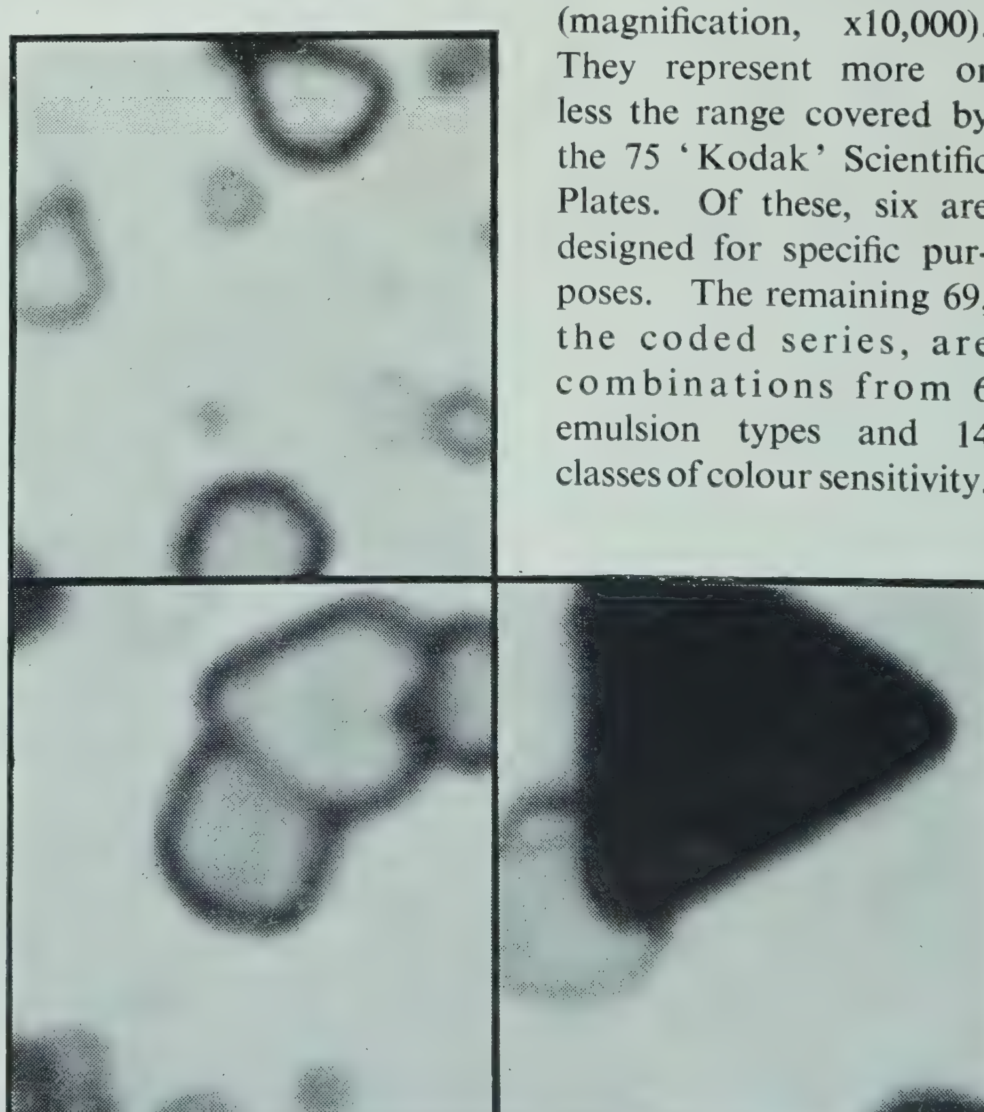

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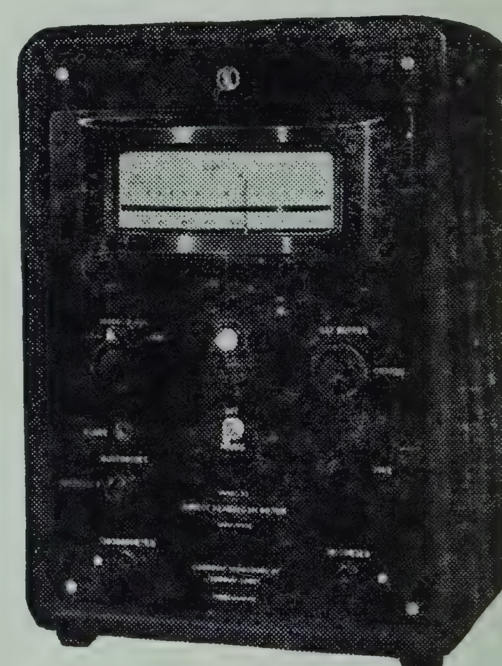

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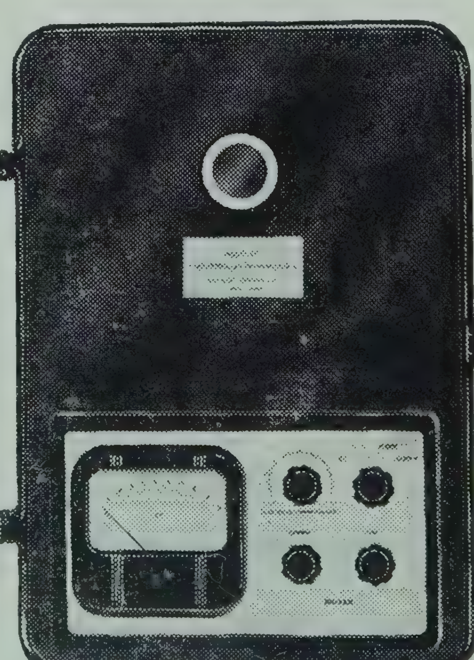

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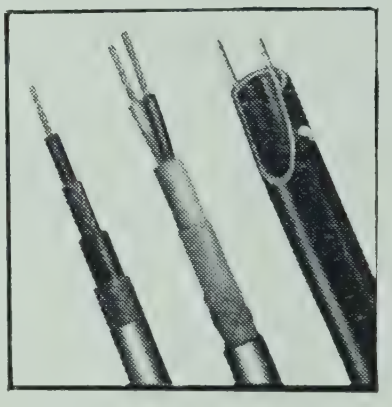

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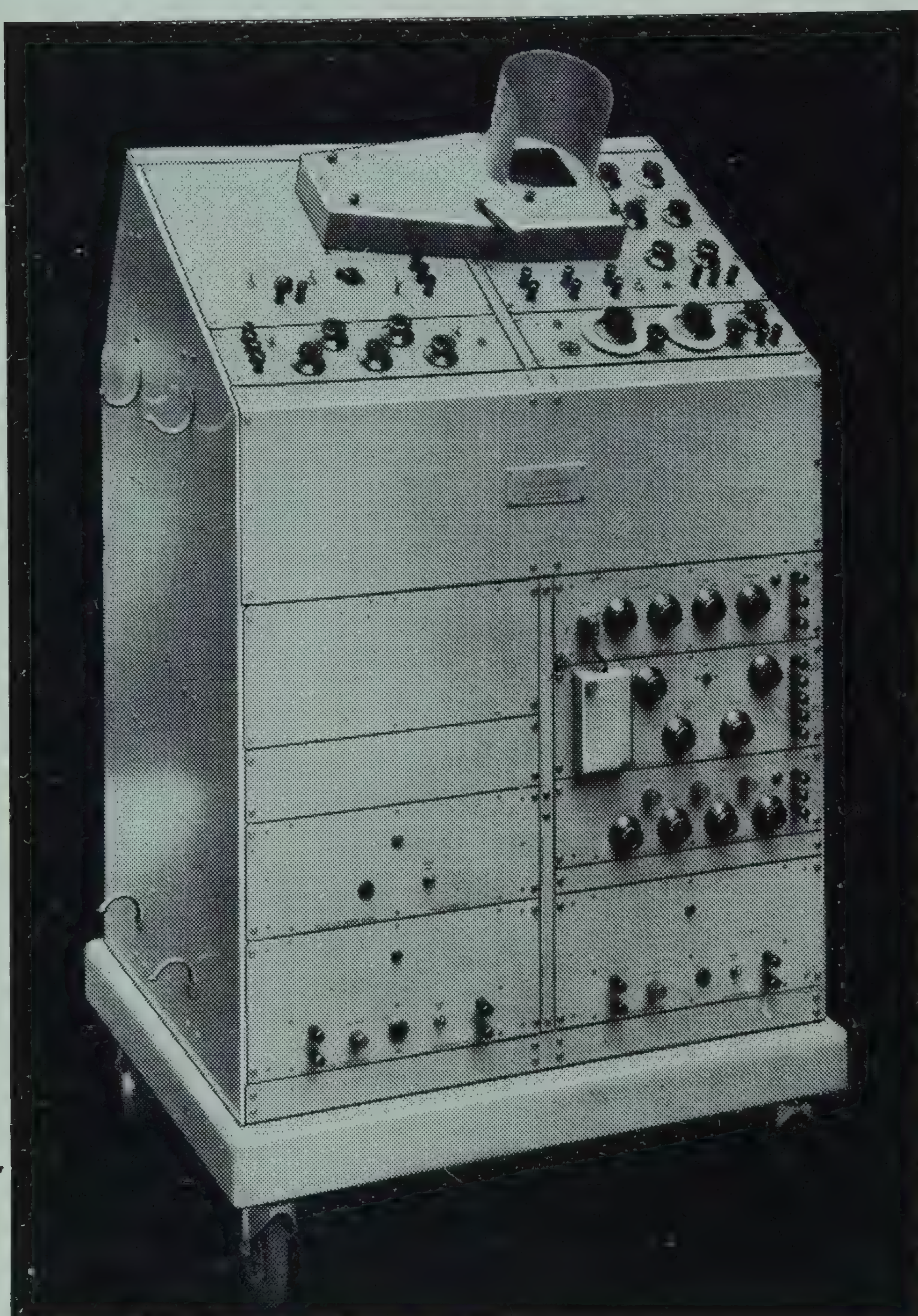

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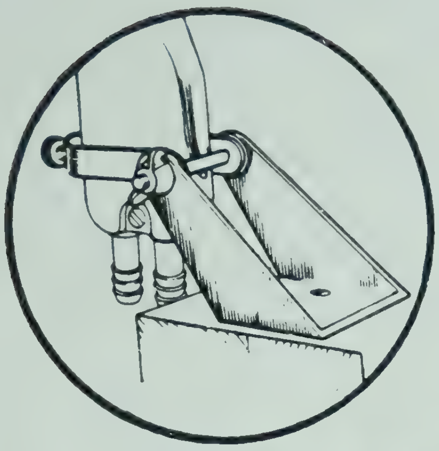
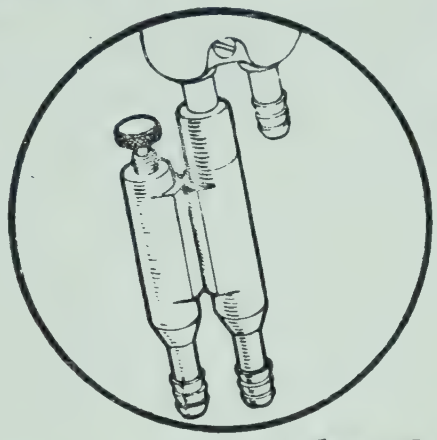
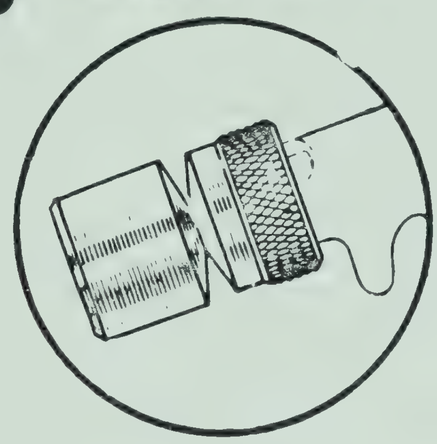


Flamemaster



plus three



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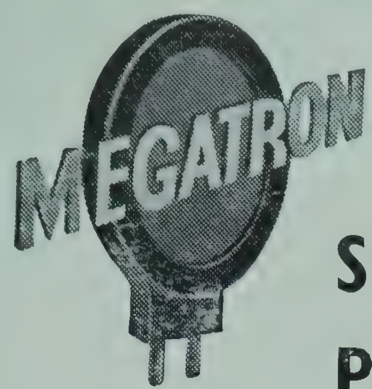

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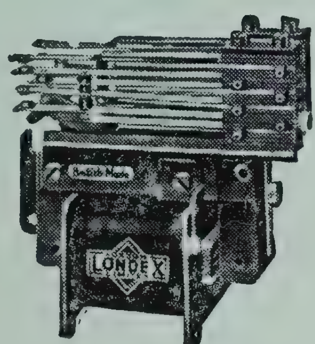

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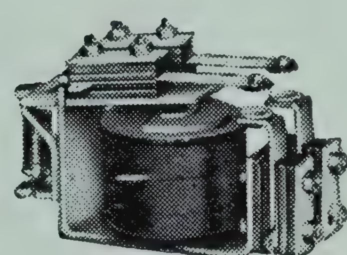
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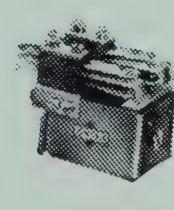
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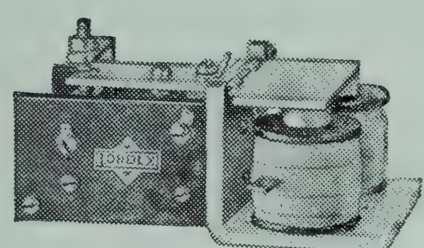
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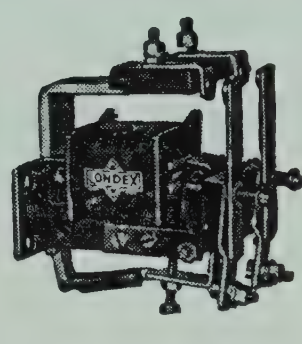
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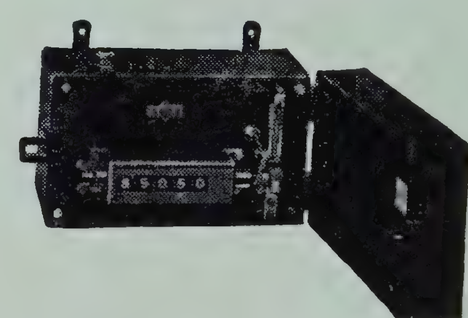
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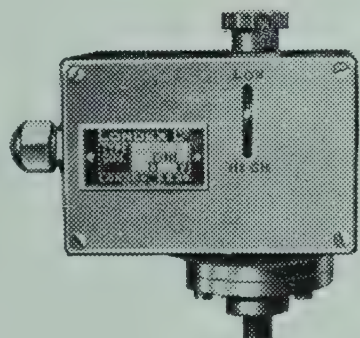
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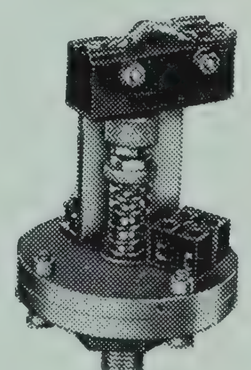
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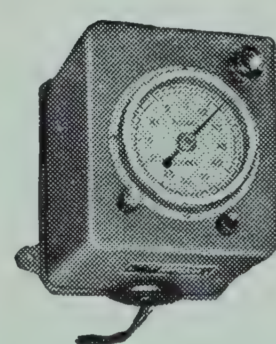
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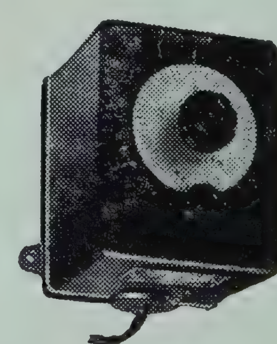
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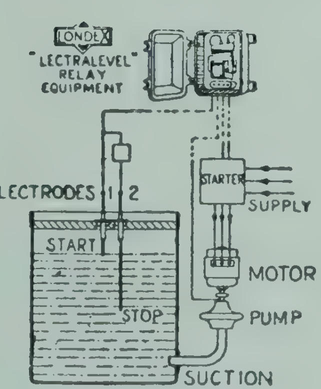

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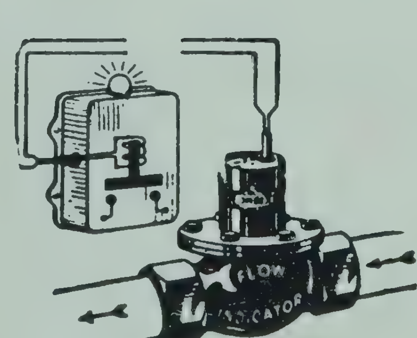

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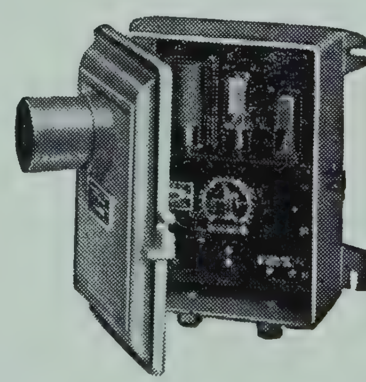

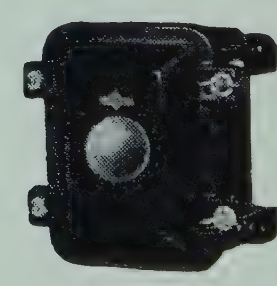
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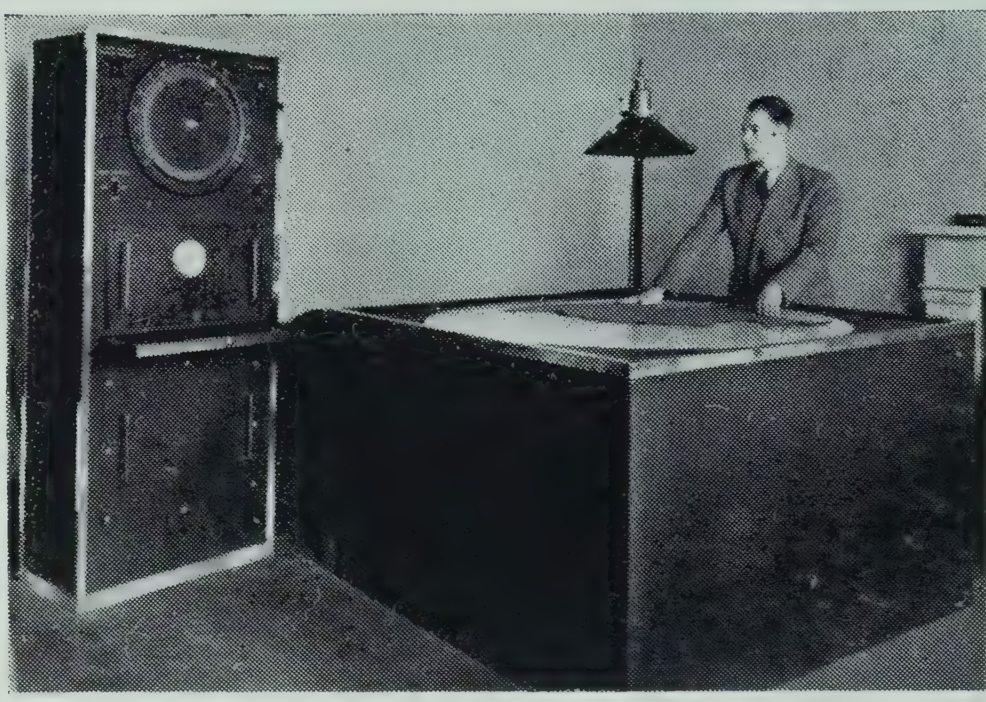

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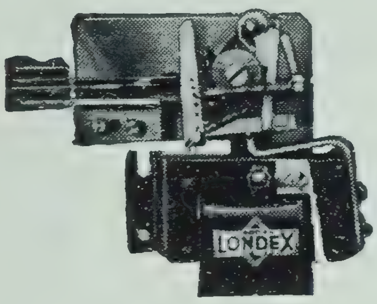

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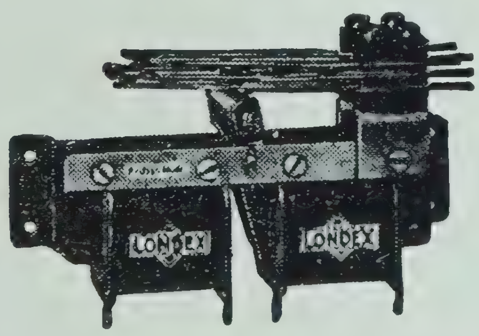

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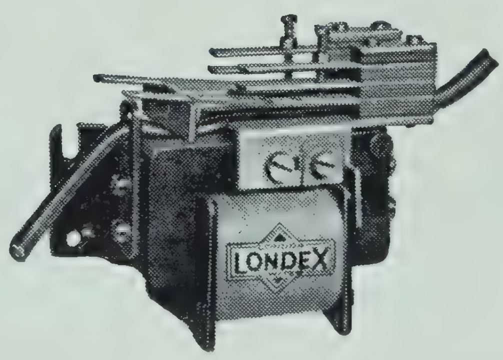

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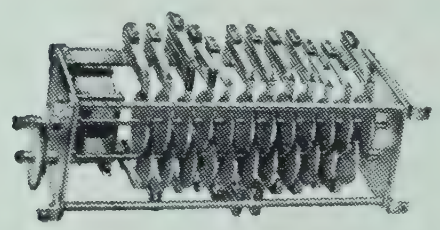

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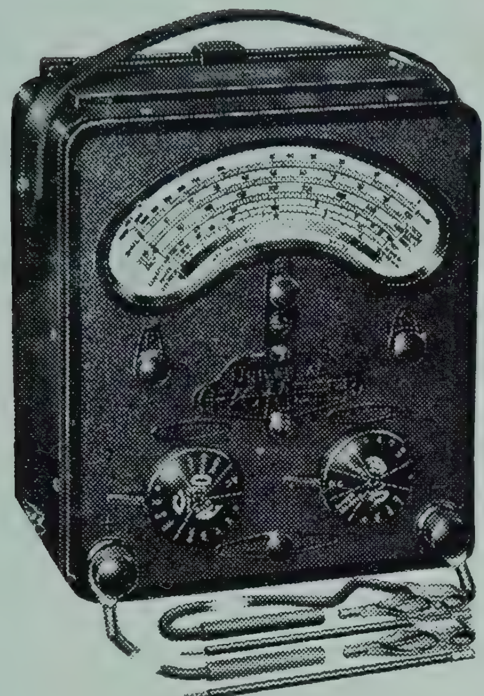

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Resistance : Up to 40 megohms.

Capacity : 0-20 μF.

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Decibels : —25 Db. to + 16 Db.

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Similar in design and appearance to t Model 7 AvoMeter. Fitted with automa overload cut-out.

Current : A.C. and D.C. 0 to 12 amp

Voltage : A.C. and D.C. 0 to 1,200 vol

Resistance : Up to 1 megohm.

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D.C. Current: 50 μA to 1,000 mA.
D.C. Voltage : 2.5 V. to 2,500 V.
A.C. Voltage : 10 V. to 2,500 V.

Resistance :
Model 1 : 0.1 ohm to 5 megohms.
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Resistance : 0-500 ohms. (Midscale 12.5 ohms).
0-50,000 ohms. (Midscale 1,250 ohms).

Sensitivity : D.C. voltage ranges, 1,000 ohms per volt.
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Rectifying and signal diodes are tested under load conditions. A specially develope polarised relay protects the instrument against an incorrect adjustment or misus and also offers a high measure of protection to the valve under test. The uniqu "Avo" rotary selector switch enables basing data of any valve to be set up in a fe seconds. Operates on A.C. 100-230 volts, 50–60 c/s.

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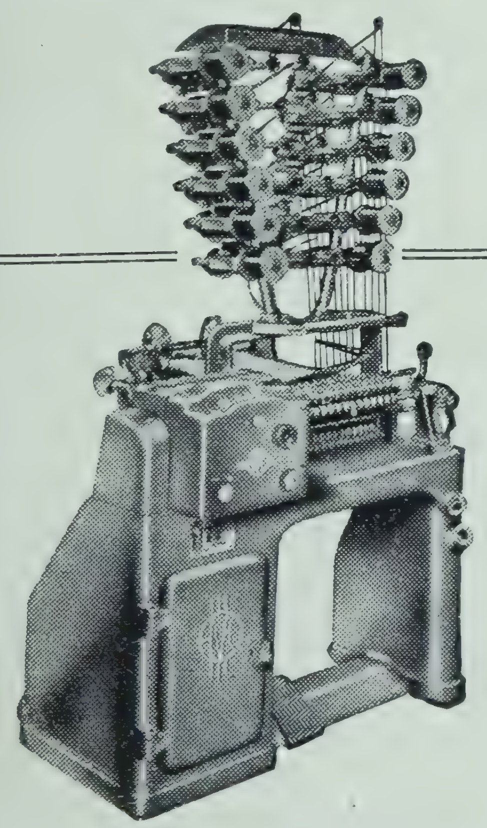
Inductance : 50 mH. to 500 H.

Power supply : 100-110 and 200-250 volts A.C., 50 c/s.

Size : 13 x $10\frac{1}{4}$ x 5 *ins.* *Weight :* 9 *lbs.*



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The instrument consists basically of a balanced bridge valve voltmeter. It inc porates many unique features and a wide set of ranges, so that in operation it is simple to use as a normal multi-range testmeter.

Gives 56 ranges of readings :

D.C. Volts : 2.5 mV. to 250 V.
(Input Resistance 11.0 megohms.)
25 mV. to 10,000 V.
(Input Resistance 110.0 megohms)

D.C. Current : 0.25 μA. to 1 am.p 250 mV. drop on all ranges.

A.C. Volts : 0.1 V. to 2,500 V. R.M.S. up to 1 Mc/s. With diode probe external 0.1 V. to 250 V. R.M.S. Useful measurements can be made up to 200 Mc/s., the applied voltage bein limited to 100 V. above 50 Mc/s.

A.C. Output Power : 5 mW. to 5 watt in six different load resistances fro 5 to 5,000 ohms.

Decibels : — 10 Db. to + 20 Db.

Capacitance : .0001 μF. to 50 μF.

Resistance : 0.2 ohm to 10 megohms.

Insulation : 0.1 megohms to 1,000 meg ohms.

The thermionic circuit gives delicate galvanometer sensitivity to a robust movin coil movement, which it is almost impossible to damage by overload. The instrume is quickly set up for any of the various tests to be undertaken, a single range select switch automatically removing from the circuit any voltages and controls not requir for the test in question.

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Size : $12\frac{1}{2}$ x 9 x $5\frac{1}{2}$ *ins.*
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50 Kc/s.—150 Kc/s.	1.5 Mc/s.—5.5 Mc/s.
150 Kc/s.—500 Kc/s.	5.5 Mc/s.—20 Mc/s.
500 Kc/s.—1.5 Mc/s.	20 Mc/s.—80 Mc/s.

The H.F. Circuit is a modified Colpitts Oscillator giving good waveform and sensibly constant level of signal over the full frequency ranges. A slide wire attenuator fed from a non-reactive multiplier gives a calibrated output from 1 μV. up to 50 mV. into a matched concentric cable of 80 ohms impedance terminating in a screened All-Wave Dummy Aerial. A very efficient double screening system is provided. A force output signal at approximately .5 V. is available at a separate output socket.

Switching enables modulated or unmodulated R.F. signals to be obtained, modulation being provided to a depth of 30% by a 400 c/s. signal of good wave form. Provision is made for the external modulation of the pure R.F. signal and sockets are provided where a 400 c/s. signal is available via a variable potentiometer for test purposes. The fr quency calibration is accurate to within $\pm$ 1% of the readings given upon a large clear marked dial. The instrument is operated from 100 V. — 250 V. 40 — 60 c/s. A.C. mai A Battery-operated model is available, covering a frequency band of 60 Kc/s. — 70 Mc

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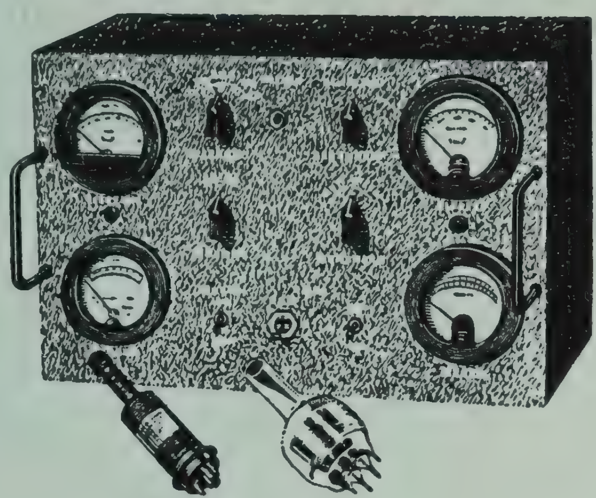
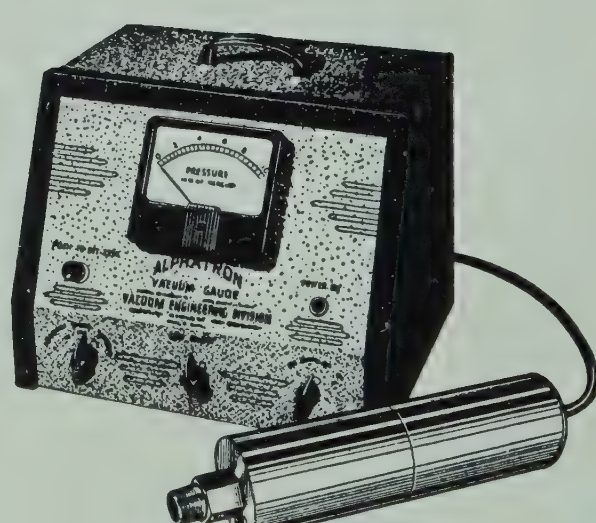


THE B.A.R. THERMOCOUPLE-IONISATION GAUGE CONTROL

The newly developed Thermocouple-Ionisation Gauge Control, complete with Thermocouple and Ionisation Gauges, covers the pressure range from 2×10^{-7} mm. to 1 mm. Hg. Operation is dependable and simple. Ranges are 10^{-3}–1 mm. and 0–5, 0–1·0, 0–0·1, 0–0·01 microns. The unit is removable from its cabinet for incorporation in a central panel.

THE B.A.R. ALPHATRON

is an ionisation-type vacuum gauge using the ionising power of alpha particles from a radium source to measure total pressure of any gas, vapour or mixed atmosphere from 1 micron to 10 mm. Hg with instantaneous linear response. The B.A.R. Alphatron is quickly available from batches now in production.



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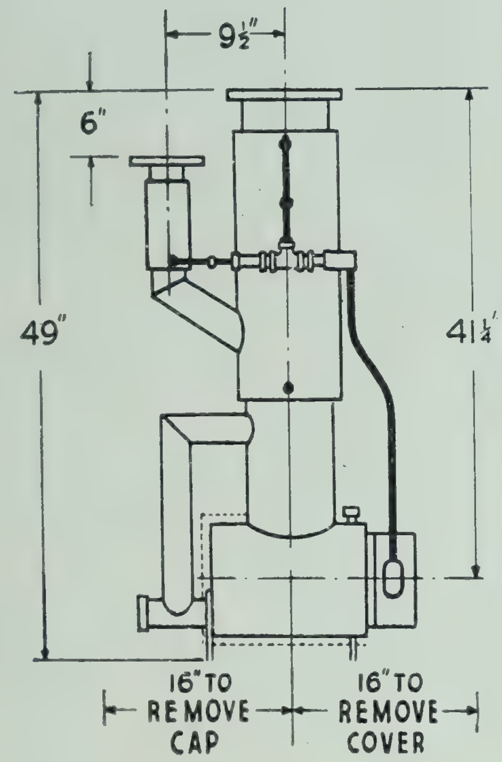

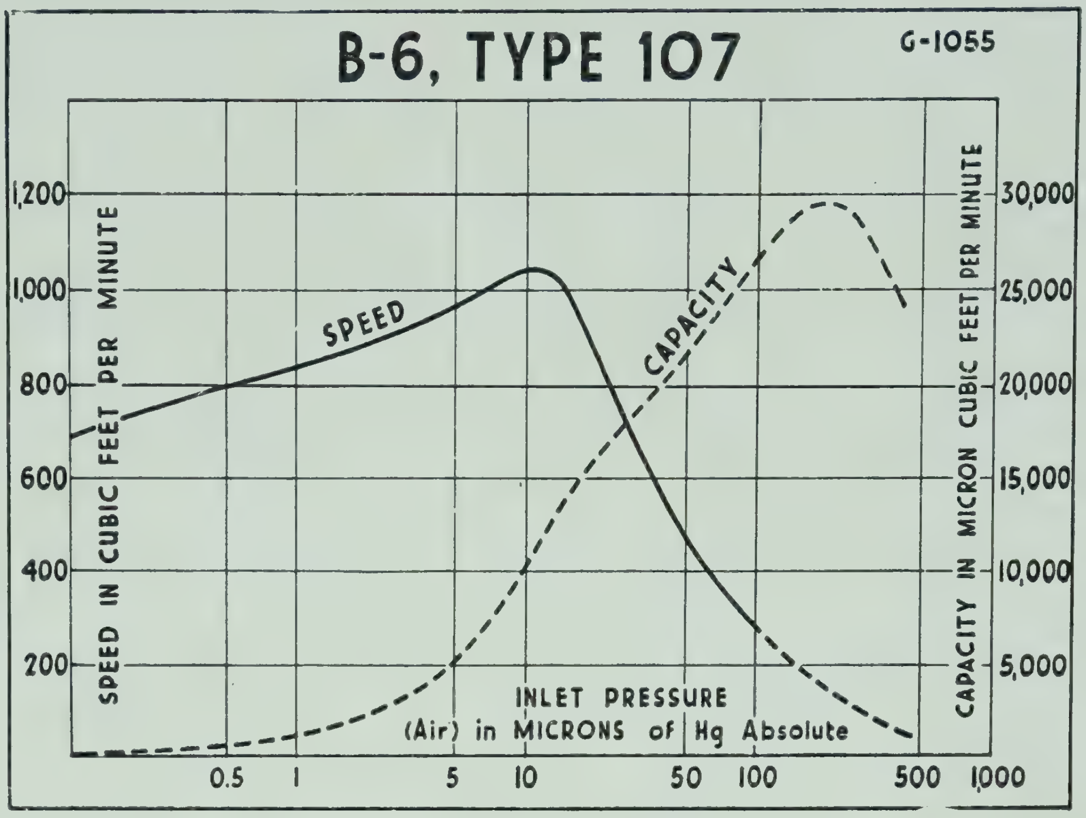

B-6, TYPE 107 BOOSTER PUMP

The performance curve shows that the B-6 is designed to supply a large pumping capacity in the pressure interval where the efficiencies of the mechanical and ordinary diffusion pumps are low. At 50 microns the B-6, backed by a 100 CFM mechanical pump, is handling approximately the same capacity as a 700 CFM mechanical pump. The advantages of using the booster are low initial costs and low operating costs.

HIGH VACUUM BELLOWS SEALS

B.A.R. specialise in supplying Rotary bellows seals for imparting motion into high vacuum chambers. These seals permit continuous rotary motion and are easily installed. There are no packings and the gaskets are on the outside of the chamber. Wide experience of high vacuum requirements demands the use of corrosion-resisting materials and design which permits adjustability to a wide range of vessel-wall thicknesses. Other specialities are seals suitable for high voltage leads, metal to glass and metal to metal vacuum-tight tubing joints and seals for pipes for the introduction of gases and liquids into vacuum systems.

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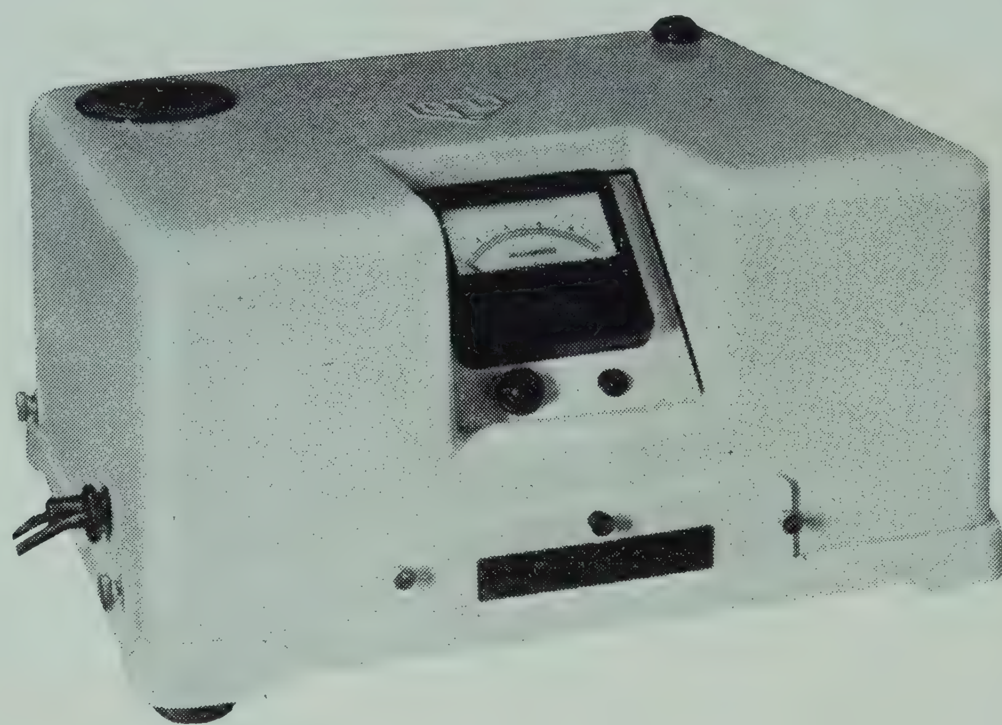

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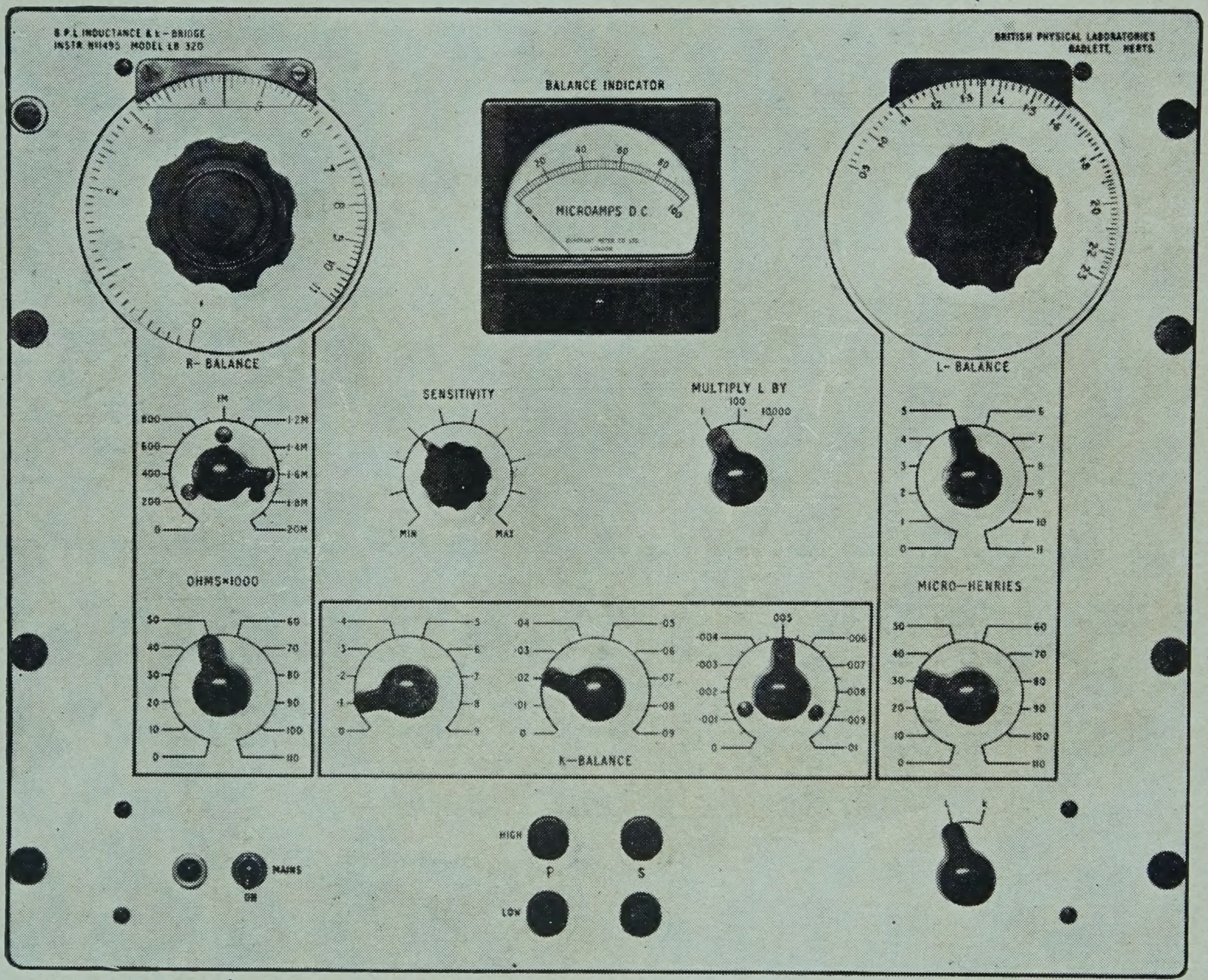

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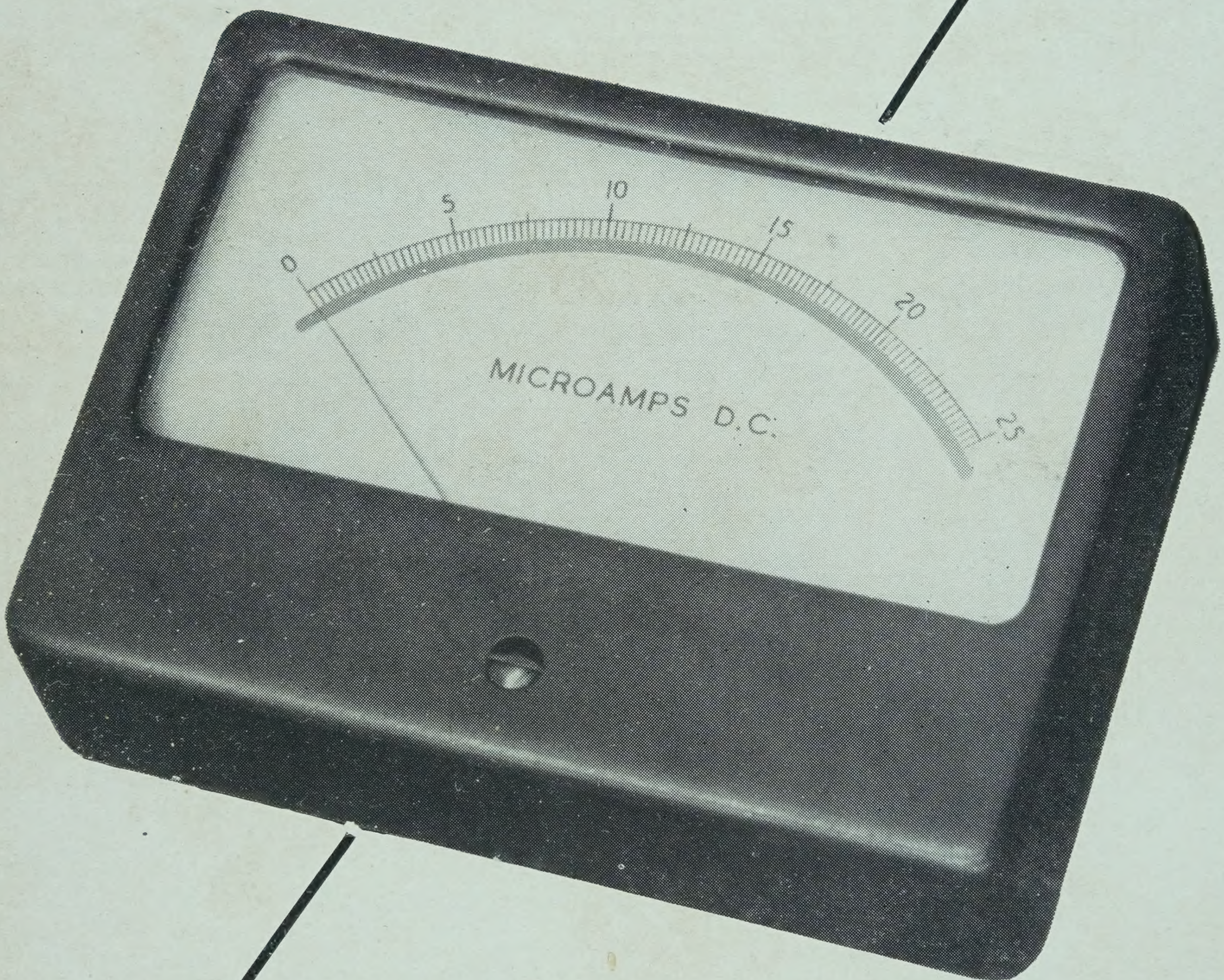

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